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*Arrivalstar S.A. and Melvino Technologies Limited*

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**IN THE UNITED STATES DISTRICT COURT**
**FOR THE SOUTHERN DISTRICT OF NEW YORK**

| | |
|---|---|
| ARRIVALSTAR S.A. and MELVINO TECHNOLOGIES LIMITED,<br><br>Plaintiffs,<br><br>vs.<br><br>THE PORT AUTHORITY OF NEW YORK AND NEW JERSEY<br><br>Defendant. | **Case No.:**<br><br>**DEMAND FOR JURY TRIAL** |

## COMPLAINT FOR PATENT INFRINGEMENT

Plaintiffs ArrivalStar S.A. and Melvino Technologies Limited (collectively, "ArrivalStar" or "Plaintiffs"), by and through their undersigned attorneys, for their complaint against defendant the Port Authority of New York and New Jersey ("Port Authority")(the Port Authority is referred to herein as "Defendant") hereby allege as follows:

## NATURE OF LAWSUIT

1. This action involves claims for patent infringement arising under the patent laws of the United States, Title 35 of the United States Code. This Court has exclusive jurisdiction over the subject matter of the Complaint under 28 U.S.C. § 1338(a).

## THE PARTIES

2. ArrivalStar S.A. is a corporation organized under the laws of Luxembourg and having offices at 67 Rue Michel, Welter L-2730, Luxembourg.

3. Melvino Technologies Limited is a corporation organized under the laws of the British Virgin Island of Tortola, having offices at P.O. Box 3152, RG Hodge Building, Road Town, Tortola, British Virgin Islands.

4. ArrivalStar owns all right, title and interest in, and has standing to sue for infringement of United States Patent No. 6,317,060 ("the '060 patent"), entitled "Base station system and method for monitoring travel of mobile vehicles and communicating notification messages," issued November 13, 2001. A copy of the '060 patent is annexed hereto as Exhibit A.

5. ArrivalStar owns all right, title and interest in, and has standing to sue for infringement of United States Patent No. 7,030,781 ("the '781 patent"), entitled "Notification system and method that informs a party of vehicle delay," issued April 18, 2006. A copy of the '781 patent is annexed hereto as Exhibit B.

6. Defendant Port Authority is an authority created by a compact between the States of New York and New Jersey in 1921 with the consent of Congress of the United States of America with a place of business at 225 Park Avenue South, New York, New York

10003. The Port Authority transacts business and has, at a minimum, offered to provide and/or provided in this judicial district and throughout the State of New York services that infringe claims of the '060 and '781 patents.

7. Venue is proper in this District under 28 U.S.C. §§ 1391 and 1400(b).

**DEFENDANT PORT AUTHORITY'S ACTS OF PATENT INFRINGEMENT**

8. Defendant Port Authority has infringed claims of the '060 and '781 patents through, among other activities, the use of the Port Authority's PATHAlerts system.

9. Defendant Port Authority's infringement has injured and will continue to injure ArrivalStar unless and until this Court enters an injunction prohibiting further infringement and, specifically, enjoining further use of methods and systems that come within the scope of the '060 and '781 patents.

**PRAYER FOR RELIEF**

WHEREFORE, Plaintiffs ask this Court to enter judgment against the Defendant, and against their subsidiaries, affiliates, agents, servants, employees and all persons in active concert or participation with them, granting the following relief:

A. An award of damages adequate to compensate ArrivalStar for the infringement that has occurred, together with prejudgment interest from the date that Defendant's infringement of the ArrivalStar patents began;

B. Increased damages as permitted under 35 U.S.C. § 284;

C. A finding that this case is exceptional and an award to ArrivalStar of its attorneys' fees and costs as provided by 35 U.S.C. § 285;

D. A permanent injunction prohibiting further infringement, inducement and contributory infringement of the ArrivalStar patents; and

E. Such other and further relief as this Court or a jury may deem proper and just.

**JURY DEMAND**

ArrivalStar demands a trial by jury on all issues presented in this Complaint.

Respectfully submitted,

**EPSTEIN DRANGEL LLP**

Dated: March 15, 2011

By:____________________

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**ARRIVALSTAR S.A. and**
**MELVINO TECHNOLOGIES LIMITED**

**Index of Exhibits**

# EXHIBIT A

US006317060B1

(12) **United States Patent**
**Jones**

(10) **Patent No.: US 6,317,060 B1**
(45) **Date of Patent: *Nov. 13, 2001**

(54) **BASE STATION SYSTEM AND METHOD FOR MONITORING TRAVEL OF MOBILE VEHICLES AND COMMUNICATING NOTIFICATION MESSAGES**

(75) Inventor: **Martin Kelly Jones**, Vancouver (CA)

(73) Assignee: **Global Research Systems, Inc.**, Rome, GA (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/516,577**

(22) Filed: **Mar. 1, 2000**

**Related U.S. Application Data**

(60) Provisional application No. 60/122,482, filed on Mar. 1, 1999.

(51) **Int. Cl.**[7] .......... **G08G 1/123**

(52) **U.S. Cl.** .......... **340/994**; 340/989; 340/993; 701/204

(58) **Field of Search** .......... 340/994, 982, 340/989, 990, 991, 995, 906, 907, 539, 993; 701/204, 205, 206, 207, 208, 302

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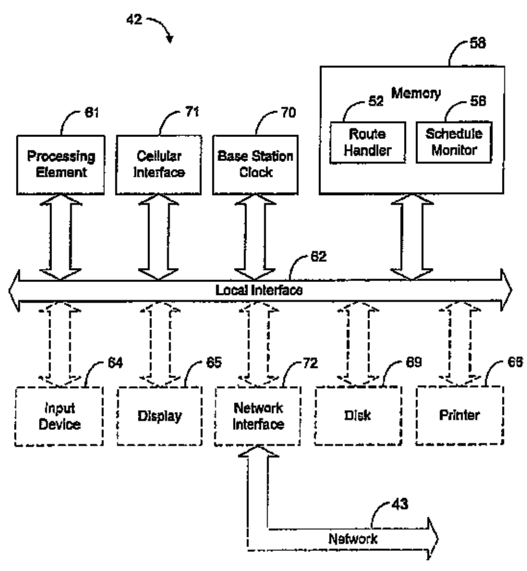
*Primary Examiner*—Benjamin C. Lee
(74) *Attorney, Agent, or Firm*—Thomas, Kayden, Horstemeyer & Risley, LLP

(57) **ABSTRACT**

A vehicle monitoring and notification system includes a route handler, a schedule monitor, and a communication handler. The schedule monitor determines when users should receive notification messages based on data that indicates when vehicles are expected to arrive at certain locations. The route handler communicates with vehicle control units on board vehicles to determine whether and how much any of the vehicles are off schedule. If any of the vehicles are off schedule, the route handler updates the data monitored by the schedule monitor to change when the schedule monitor determines that notification messages should be received by the users. Once the schedule monitor determines that a user should receive a notification message, the schedule monitor transmits a notification request to the communication handler. The communication handler then establishes communication with a communication device associated with the user and transmits a notification message to the user. Therefore, the user is warned of an impending arrival of a vehicle at a particular location.

**23 Claims, 11 Drawing Sheets**



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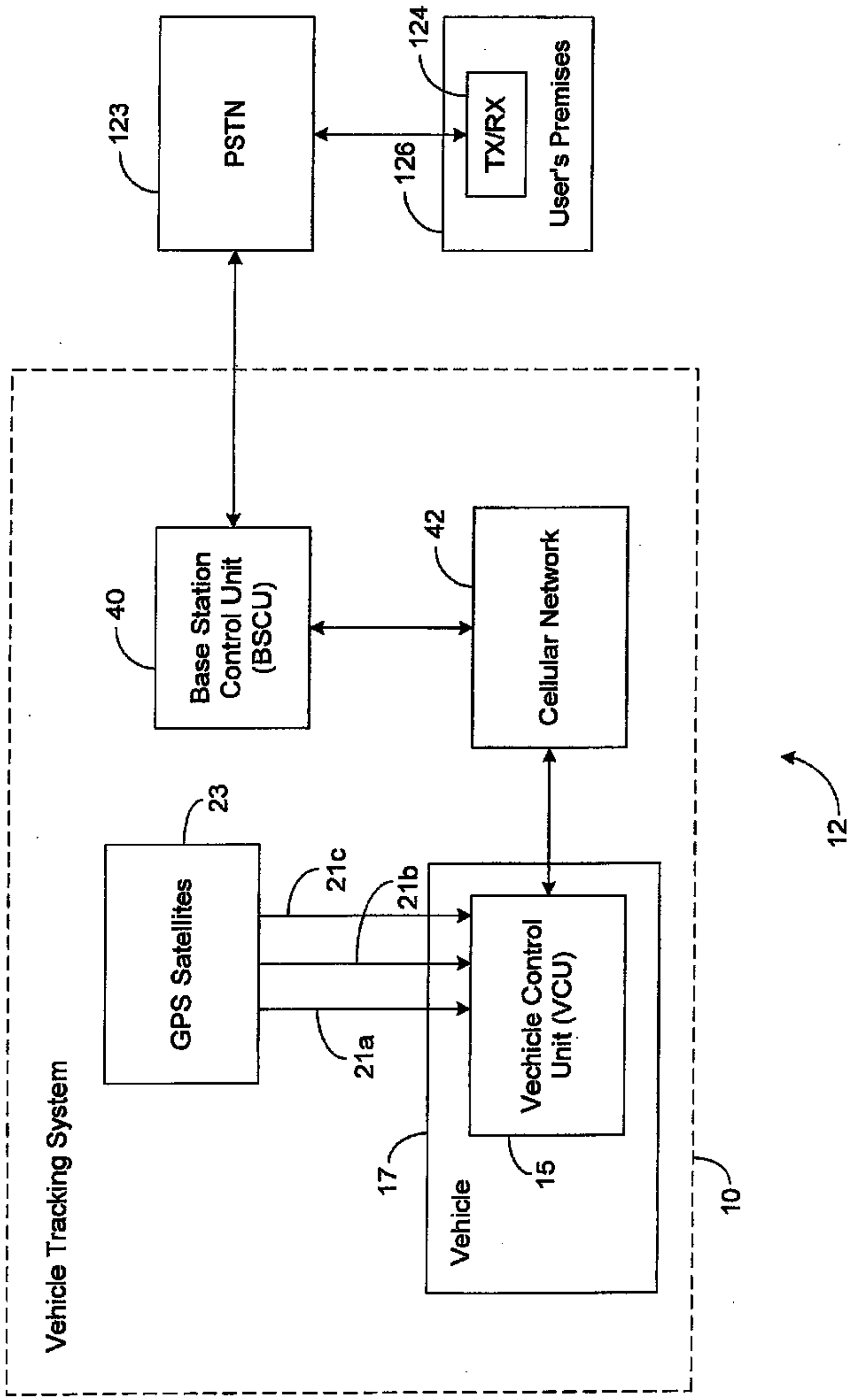


PSTN
123
TX/RX
124
126
User's Premises
Base Station Control Unit (BSCU)
40
Cellular Network
42
GPS Satellites
23
21c
21b
21a
Vechicle Control Unit (VCU)
15
Vehicle
17
Vehicle Tracking System
10
12


Fig. 1

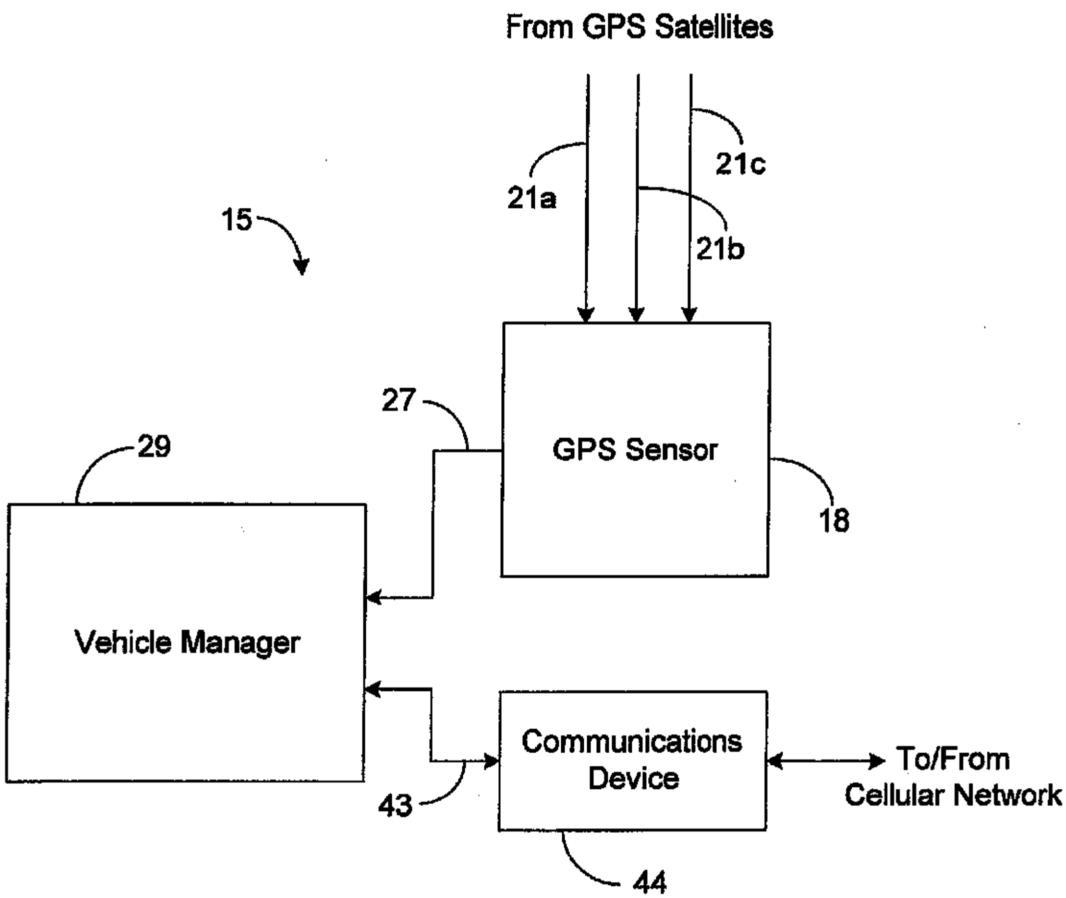

From GPS Satellites
21a
21b
21c
15
GPS Sensor
18
27
29
Vehicle Manager
Communications Device
To/From Cellular Network
43
44

Fig. 2

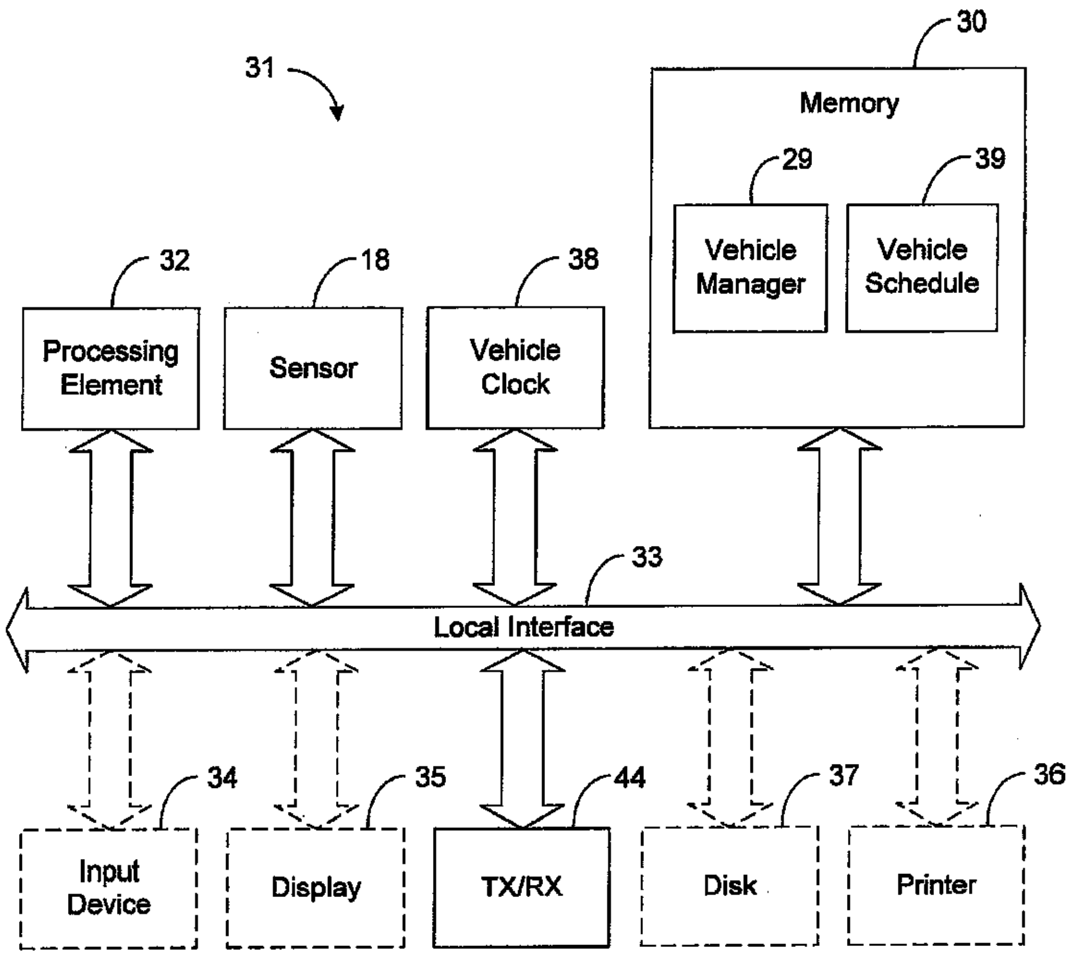

31
30
Memory
29
39
Vehicle Manager
Vehicle Schedule
32
18
38
Processing Element
Sensor
Vehicle Clock
33
Local Interface
34
35
44
37
36
Input Device
Display
TX/RX
Disk
Printer

Fig. 3

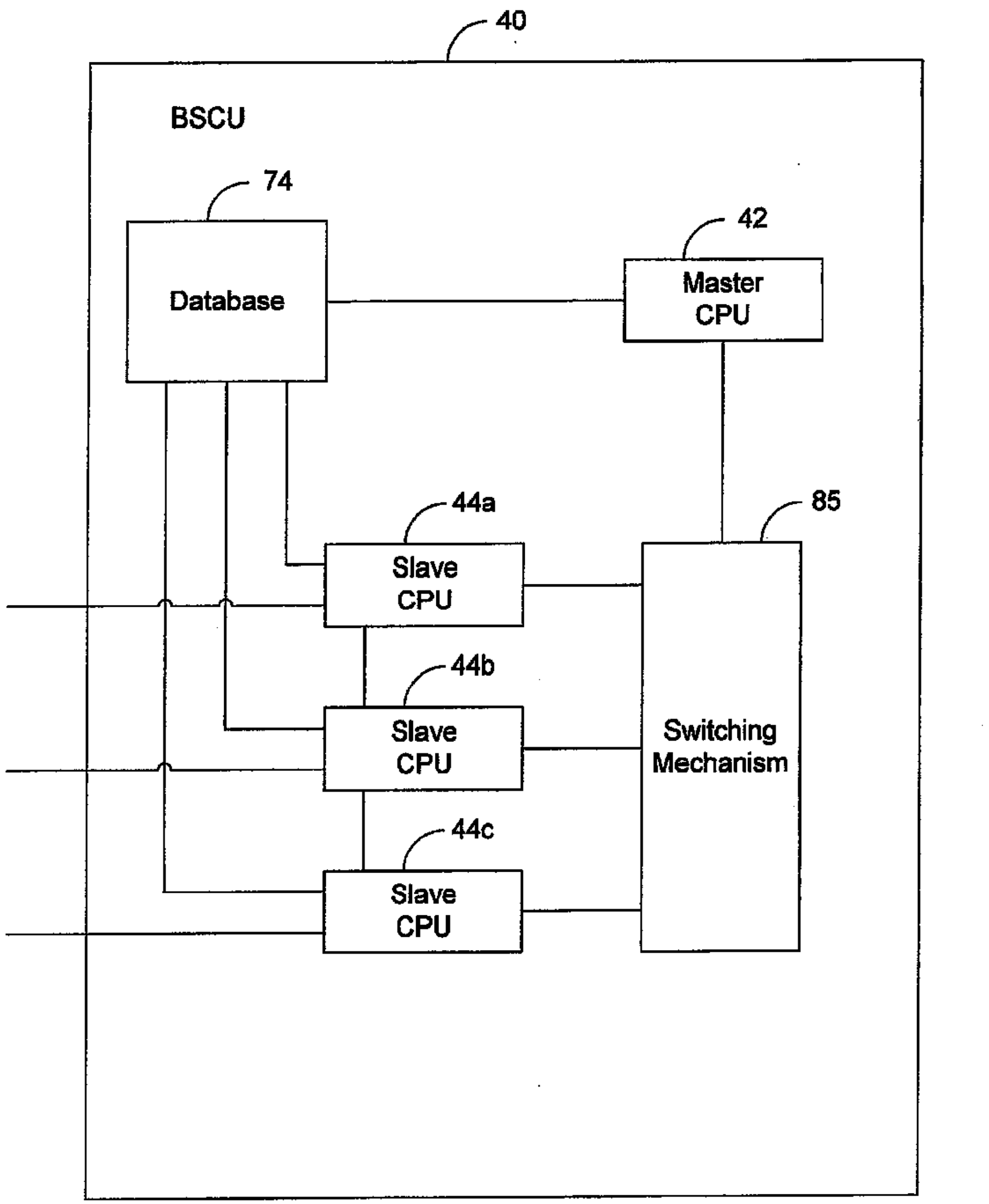

40
BSCU
74
Database
42
Master CPU
44a
Slave CPU
85
44b
Slave CPU
Switching Mechanism
44c
Slave CPU

FIG. 4

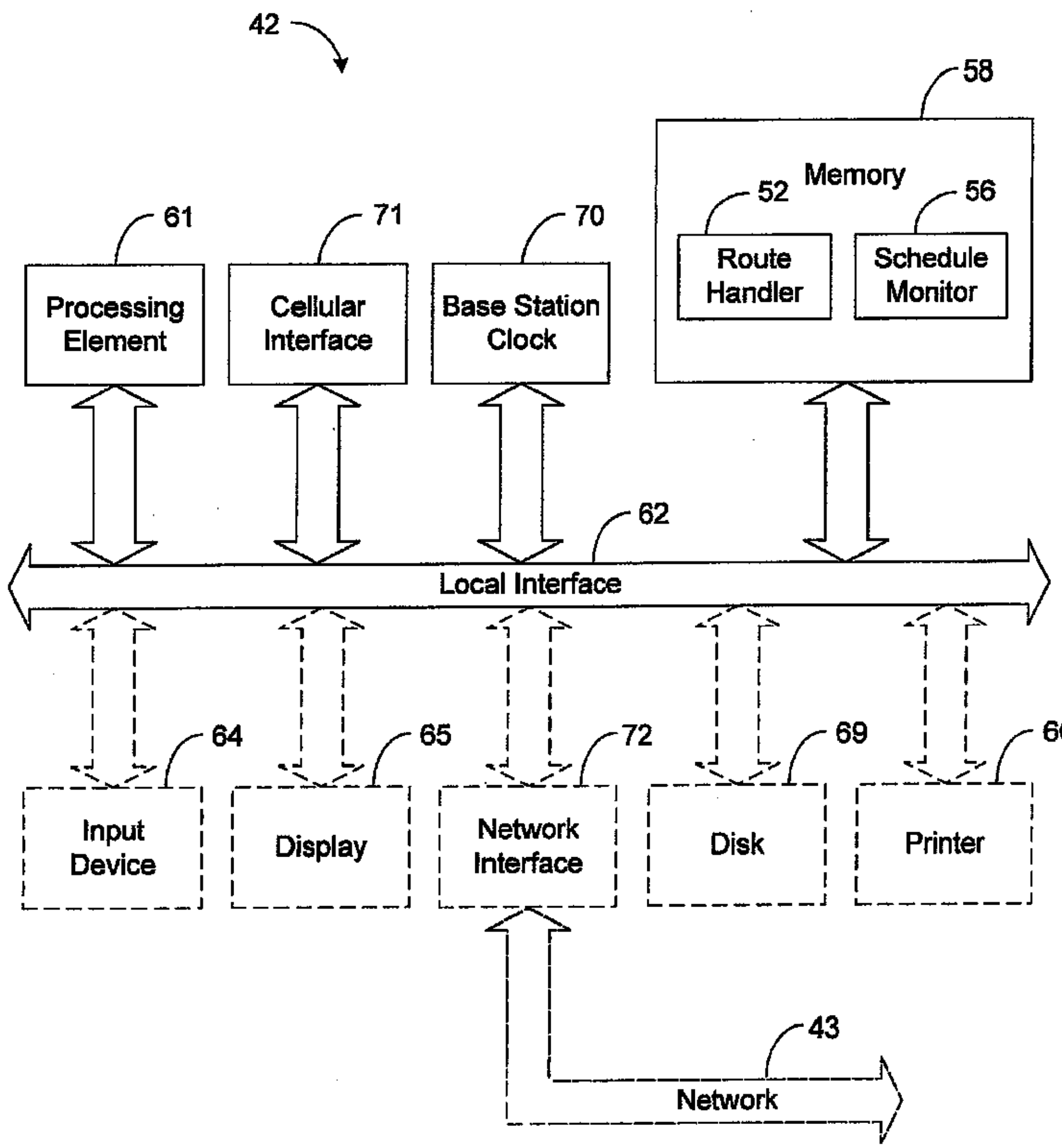

42
58
Memory
52
56
Route Handler
Schedule Monitor
61
71
70
Processing Element
Cellular Interface
Base Station Clock
62
Local Interface
64
65
72
69
66
Input Device
Display
Network Interface
Disk
Printer
43
Network

Fig. 5

81

| | TIME | Contact Information | Vechicle ID |
|---|---|---|---|
| Entry 1 | 6:30 | 1235670987 | 1112 |
| Entry 2 | 9:15 | 1235290945 | 2034 |
| Entry 3 | 12:45 | 1235467867 | 1390 |
| Entry 4 | 15:30 | 1234342313 | 0999 |

FIG. 6

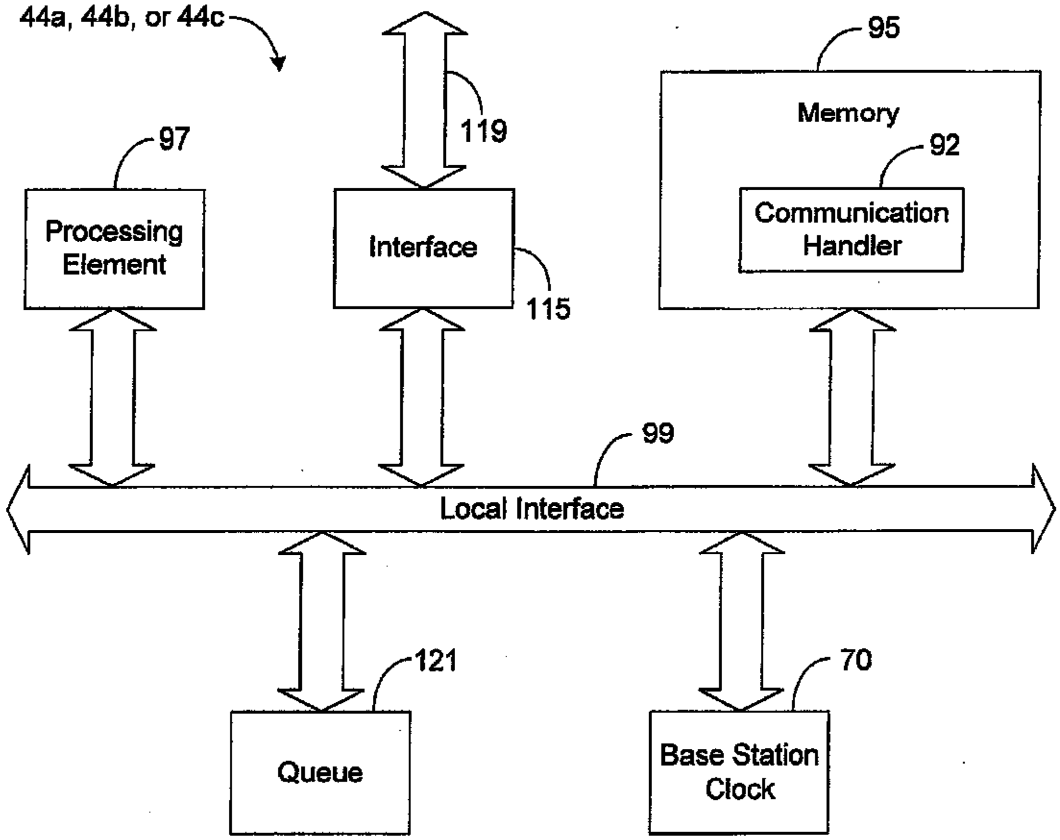

44a, 44b, or 44c
119
95
Memory
92
Communication Handler
97
Processing Element
Interface
115
99
Local Interface
121
70
Queue
Base Station Clock

FIG. 7

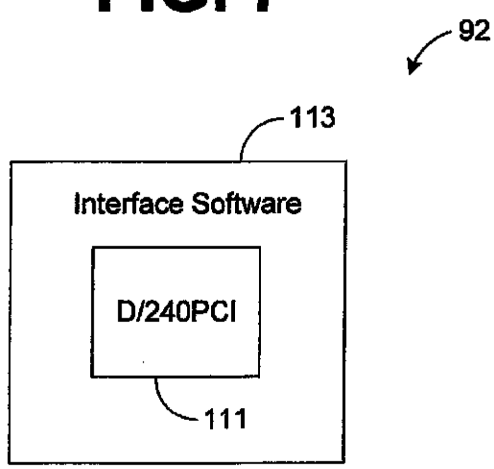

92
113
Interface Software
D/240PCI
111

FIG. 8

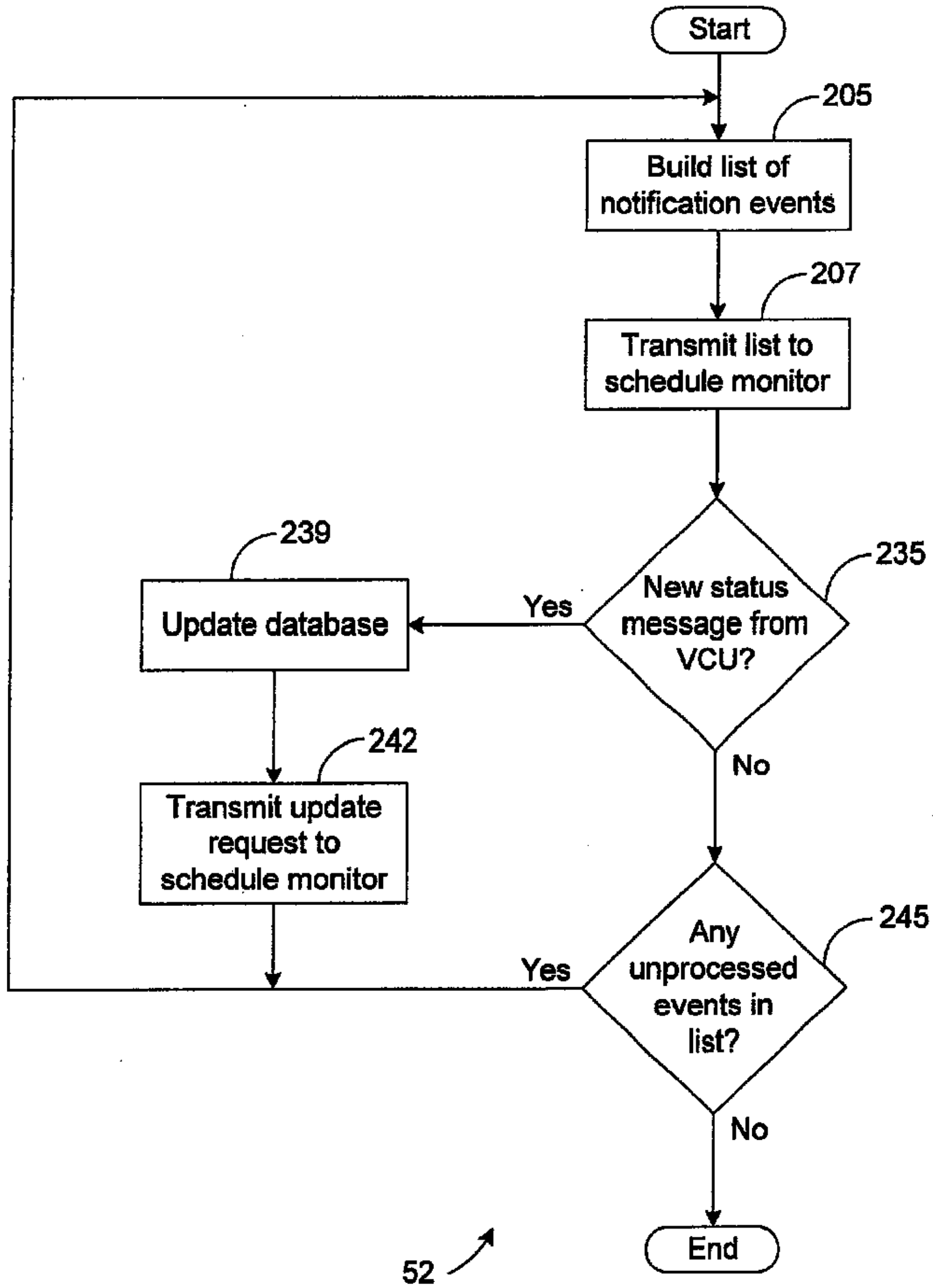
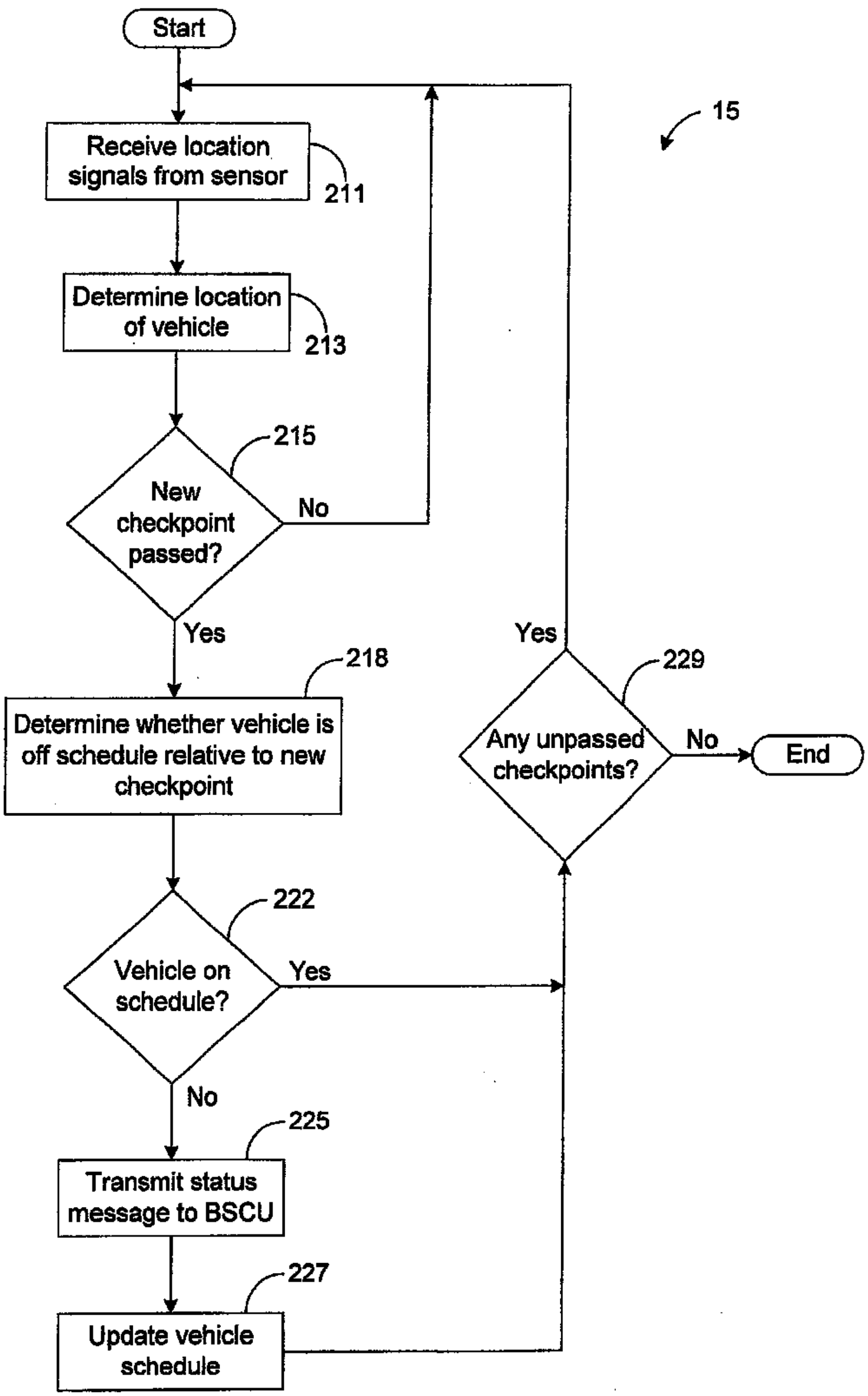

Start
205
Build list of notification events
207
Transmit list to schedule monitor
239
Update database
Yes
New status message from VCU?
235
No
242
Transmit update request to schedule monitor
Yes
Any unprocessed events in list?
245
No
End
52

FIG. 9



15
Start
Receive location signals from sensor
211
Determine location of vehicle
213
215
New checkpoint passed?
No
Yes
218
Determine whether vehicle is off schedule relative to new checkpoint
222
Vehicle on schedule?
Yes
No
225
Transmit status message to BSCU
227
Update vehicle schedule
Yes
229
Any unpassed checkpoints?
No
End


FIG. 10

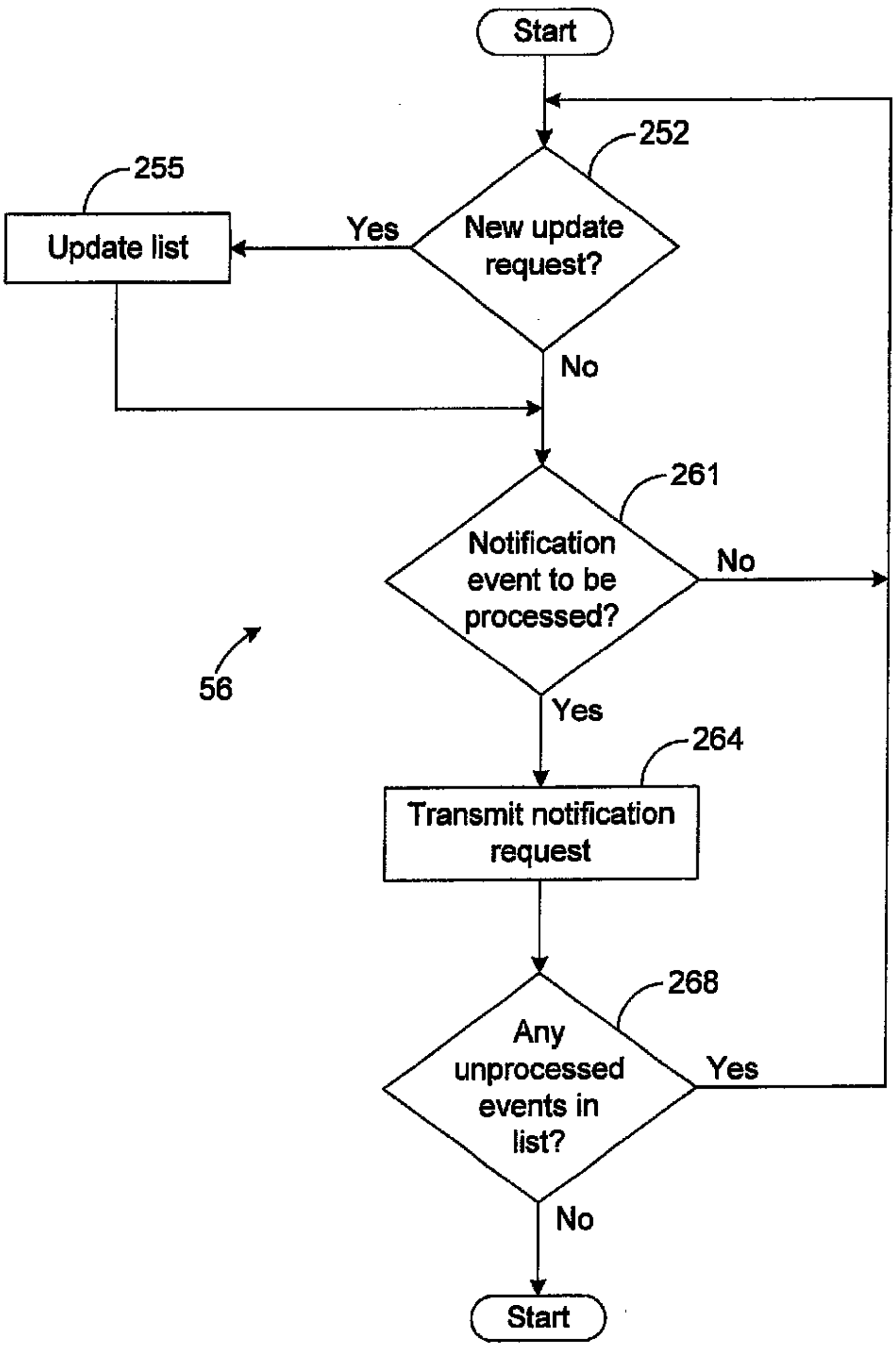

Start
252
255
Update list
Yes
New update request?
No
261
Notification event to be processed?
No
56
Yes
264
Transmit notification request
268
Any unprocessed events in list?
Yes
No
Start

FIG. 11

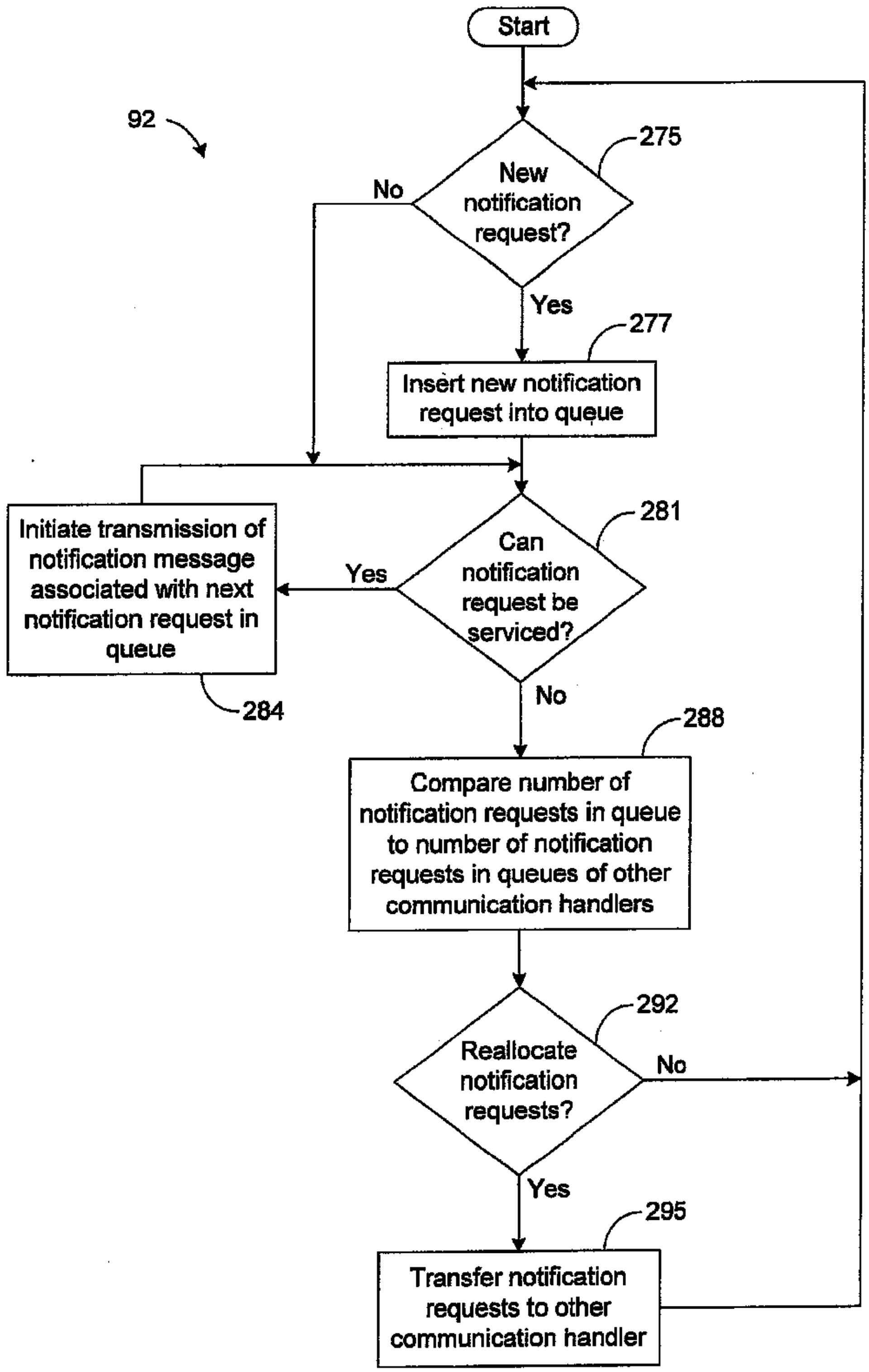

92
Start
New notification request?
275
No
Yes
Insert new notification request into queue
277
Can notification request be serviced?
281
Yes
No
Initiate transmission of notification message associated with next notification request in queue
284
Compare number of notification requests in queue to number of notification requests in queues of other communication handlers
288
Reallocate notification requests?
292
No
Yes
Transfer notification requests to other communication handler
295

FIG. 12

# BASE STATION SYSTEM AND METHOD FOR MONITORING TRAVEL OF MOBILE VEHICLES AND COMMUNICATING NOTIFICATION MESSAGES

## CLAIM OF PRIORITY AND CROSS REFERENCE TO RELATED APPLICATIONS

This document claims priority to U.S. provisional patent application entitled "BASE STATION APPARATUS AND METHOD FOR MONITORING TRAVEL OF MOBILE VEHICLE," assigned Ser. No. 60/122,482 and filed on Mar. 1, 1999, which is incorporated herein by reference.

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to vehicle monitoring and messaging systems and, in particular, to a vehicle monitoring system and method capable of communicating a plurality of notification messages to warn users of impending arrivals of vehicles.

2. Related Art

U.S. Pat. No. 5,400,020, entitled "Advance Notification System and Method," which is incorporated herein by reference, describes a system and method for communicating notification messages to users to warn the users of impending arrivals of vehicles. In this regard, each vehicle associated with the system is equipped with a tracking sensor, which is used to determine the location of the vehicle. Location signals indicating the location of the vehicle as the vehicle travels are transmitted to a base station control unit, which monitors the travel of the vehicle. When the vehicle is within a predefined time or distance of a particular location, the base station control unit transmits a notification message to a user. Therefore, the user is warned of the impending arrival of the vehicle at the particular location.

However, the base station control unit may be used to monitor the travel of a large number of vehicles or may be used to warn a large number of users of impending arrivals of a vehicle or vehicles. Furthermore, servicing a large number of vehicles and/or users may result in the need to simultaneously transmit a large number of notification messages. Accordingly, the ability to efficiently process data for a large number of vehicles and/or users and to efficiently transmit a large number of notification messages is critical in many applications.

Thus, a heretofore unaddressed need exists in the industry for better systems, apparatuses, and methods for accurately and efficiently tracking and/or reporting the status of mobile vehicles as the vehicles travel.

## SUMMARY OF THE INVENTION

The present invention overcomes many inadequacies and deficiencies of the prior art, as discussed hereinbefore. In general, the present invention provides an automated computer-based apparatus and method for monitoring travel of vehicles and for efficiently communicating notification messages to warn users of impending arrivals of the vehicles.

In a broad sense, the automated computer-based apparatus of the present invention includes a route handler, a schedule monitor, and a communication handler. The schedule monitor determines when users should receive notification messages based on data that indicates when vehicles are expected to arrive at certain locations. The route handler



communicates with vehicle control units on board the vehicles to determine how much any of the vehicles are off schedule. If any of the vehicles are off schedule, the route handler updates the data monitored by the schedule monitor to change when the schedule monitor determines that the notification messages should be received by the users.

Once the schedule monitor determines that a user should receive a notification message, the schedule monitor transmits a notification request to the communication handler. The communication handler then establishes communication with a communication device associated with the user and transmits a notification message to the user. Therefore, the user is warned of an impending arrival of a vehicle at a particular location.

In accordance with another feature of the present invention, the route handler selects portions of the data that are associated with notification events expected to occur during a particular time period. During the particular time period, the schedule monitor monitors the selected data to determine whether any notification messages should be received by users during the particular time period.

In accordance with another feature of the present invention, the communication handler stores the notification request and determines a number of notification requests stored by the communication handler. The communication handler then compares this number to a number of notification requests stored by another communication handler and transmits the notification request to the other communication handler if the difference in the two numbers exceeds a predefined threshold.

Other features and advantages of the present invention will become apparent to one skilled in the art upon examination of the following detailed description, when read in conjunction with the accompanying drawings. It is intended that all such features and advantages be included herein within the teachings of the present invention, as set forth herein and as sought to be protected by the claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention can be better understood with reference to the following drawings. The elements of the drawings are not necessarily to scale relative to each other, emphasis instead being placed upon clearly illustrating the principles of the invention. Furthermore, like reference numerals designate corresponding parts throughout the several views.

FIG. 1 is a block diagram illustrating a vehicle tracking system employed within the context of an advance notification system in accordance with the present invention.

FIG. 2 is a block diagram illustrating an implementation of the vehicle control unit of FIG. 1 in accordance with the present invention.

FIG. 3 is a block diagram illustrating a computer implementing the functionality of the vehicle control unit of FIG. 2 in accordance with the present invention.

FIG. 4 is a block diagram illustrating an implementation of the base station control unit of FIG. 1 in accordance with the present invention.

FIG. 5 is a block diagram illustrating a computer implementing the functionality of the master computer depicted in FIG. 4 in accordance with the present invention.

FIG. 6 is a schematic illustrating an exemplary list of notification events generated by the route handler of FIG. 5.

FIG. 7 is a block diagram illustrating a computer implementing the functionality of the slave computers depicted in FIG. 4 in accordance with the present invention.

FIG. **8** is a block diagram illustrating a more detailed view of the communication handler depicted in FIG. **7**.

FIG. **9** is a flow chart illustrating the architecture, functionality, and operation of the route handler of FIG. **5**.

FIG. **10** is a flow chart illustrating the architecture, functionality, and operation of the vehicle control unit of FIG. **2** while the vehicle control unit is tracking the vehicle of FIG. **1**.

FIG. **11** is a flow chart illustrating the architecture, functionality, and operation of the communication handler of FIG. **5**.

FIG. **12** is a flow chart illustrating the architecture, functionality, and operation of the communication handler of FIG. **7**.

## DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** depicts an automated vehicle tracking system **10** illustrating the principles of the present invention. As shown by FIG. **1**, the vehicle tracking system **10** is preferably employed within the context of an automated advance notification system **12** that automatically provides advance notice of impending arrivals of vehicles at destinations or other locations.

As depicted in FIG. **1**, a vehicle control unit (VCU) **15** is disposed on a mobile vehicle **17**, which is capable of transporting the VCU **15** over various distances. U.S. patent application entitled "System and Method for an Advance Notification System for Monitoring and Reporting Proximity of a Vehicle," assigned Ser. No. 09/163,958, and filed on Sep. 30, 1998, which is incorporated herein by reference, describes an exemplary VCU **15** that may be used to implement the principles of the present invention.

Preferably, the vehicle **17** is a delivery vehicle for delivering items to a destination or for picking up items at a destination. Note that items can include many various types of packages or goods to be delivered or picked up. Furthermore, items can also include persons to be picked up or delivered, such as when a bus picks up and/or delivers passengers at different bus stops. Preferably, the vehicle **17** travels along a predetermined route in making its deliveries, and the vehicle **17** may make numerous stops along its route in order to deliver or pick up different items at different locations.

Vehicle Control Unit

A more detailed view of the VCU **15** is depicted in FIG. **2**. A sensor **18** within VCU **15** is configured to determine the location of the sensor **18** relative to a predetermined reference point. Preferably, sensor **18** is a global positioning system (GPS) sensor, although other types of positioning systems and/or sensors are also possible. For example, other types of sensors **18** that may be used to implement the principles of the present invention include, but are not limited to, an odometer or sensors associated with Glonass, Loran, Shoran, Decca, or Tacan. The GPS sensor **18** is configured to receive signals **21*a*–21*c*** from a plurality of GPS satellites **23**, and as known in the art, sensor **18** is designed to analyze signals **21*a*–21*c*** to determine the sensor's location or coordinate values relative to a predetermined reference point.

For example, in the foregoing embodiment where sensor **18** is a GPS sensor, the sensor **18** determines the sensor's location values relative to the Earth's zero degree latitude and zero degree longitude reference point, which is located at the intersection of the Equator and the Prime Meridian. U.S. Pat. No. 5,781,156 entitled "GPS Receiver and Method for Processing GPS Signals" and filed on Apr. 23, 1997 by Krasner, which is incorporated herein by reference, discusses the processing of GPS signals **21*a*–21*c*** received from GPS satellites **23** in order to determine the sensor's location values. Since the sensor **18** is located on or within the vehicle **17**, the location values determined by the sensor **18** are assumed to match the location values of the vehicle **17** and the VCU **15**.



It should be noted that the term "location value" shall be defined herein to mean any value or set of values that may be used to determine a location of a point on the Earth or within the Earth's atmosphere. This value may be a distance value, a coordinate value (i.e., grid value), polar value, vector value, or any other type of value or values known in the art for indicating locations of points.

Sensor **18** is designed to periodically transmit a signal **27** to vehicle manager **29** indicating the vehicle's current location values. Vehicle manager **29** is configured to receive signal **27** and to monitor the location of the vehicle **17** over time by processing multiple signals **27**. The vehicle manager **29** can be implemented in software, hardware, or a combination thereof. Preferably, as illustrated by way of example in FIG. **3**, the vehicle manager **29** of the present invention along with its associated methodology is implemented in software and stored in computer memory **30** of a computer system **31**.

Note that the vehicle manager **29** can be stored and transported on any computer-readable medium for use by or in connection with an instruction execution system, apparatus, or device, such as a computer-based system, processor-containing system, or other system that can fetch the instructions from the instruction execution system, apparatus, or device and execute the instructions. In the context of this document, a "computer-readable medium" can be any means that can contain, store, communicate, propagate, or transport the program for use by or in connection with the instruction execution system, apparatus, or device. The computer readable medium can be, for example but not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, device, or propagation medium. More specific examples (a nonexhaustive list) of the computer-readable medium would include the following: an electrical connection (electronic) having one or more wires, a portable computer diskette (magnetic), a random access memory (RAM) (magnetic), a read-only memory (ROM) (magnetic), an erasable programmable read-only memory (EPROM or Flash memory) (magnetic), an optical fiber (optical), and a portable compact disc read-only memory (CDROM) (optical). Note that the computer-readable medium could even be paper or another suitable medium upon which the program is printed, as the program can be electronically captured, via for instance optical scanning of the paper or other medium, then compiled, interpreted or otherwise processed in a suitable manner if necessary, and then stored in a computer memory. As an example, the vehicle manager **29** may be magnetically stored and transported on a conventional portable computer diskette.

The preferred embodiment of the computer system **31** of FIG. **3** comprises one or more conventional processing elements **32**, such as a digital signal processor (DSP), that communicate to and drive the other elements within the system **31** via a local interface **33**, which can include one or more buses. Furthermore, an input device **34**, for example, a keyboard or a mouse, can be used to input data from a user of the system **31**, and screen display **35** or a printer **36** can be used to output data to the user. A disk storage mechanism

37 can be connected to the local interface 33 to transfer data to and from a nonvolatile disk (e.g., magnetic, optical, etc.). Furthermore, a vehicle clock 38 may be connected to the computer system 31 so that components of the system 31 may utilize data from the clock 38 to determine time through conventional techniques. It should be noted that input device 34, display 35, printer 36, and disk 37 are optional and are not necessarily a part of the preferred embodiment.

The vehicle manager 29 is preferably configured to maintain a predefined schedule 39, referred to herein as the "vehicle schedule 39," within memory 30. The predefined vehicle schedule 39 corresponds with a route of travel for the vehicle 17. In this regard, the predefined vehicle schedule 39 stored in memory 30 includes data defining locations or "checkpoints" along the vehicle's intended route of travel. Furthermore, each checkpoint is associated with a particular time value indicating when the vehicle 17 is expected to pass the associated checkpoint. Each checkpoint along with its associated time value may define an entry in the vehicle schedule 39.

Preferably, the time value associated with a checkpoint corresponds to a time of day that the vehicle 17 is expected to pass the checkpoint. For example, the time value associated with a checkpoint may define the hour and minute that the vehicle 17 is expected to pass the checkpoint. Consequently, when the vehicle 17 reaches the location defined by the checkpoint, the time of day, as defined by vehicle clock 38, can be compared with the time value in the schedule 39 associated with the checkpoint to determine whether the vehicle 17 is early, late, or on time. It should be noted that other data and other methodologies, such as the those disclosed in U.S. Pat. No. 5,400,020, for example, may be employed to determine whether or not the vehicle 17 is on schedule, without departing from the principles of the present invention.

As the vehicle 17 travels along its route, the vehicle manager 29 determines when the vehicle 17 passes a checkpoint by comparing the data received from sensor 18 with the checkpoint data stored in vehicle schedule 39. When the vehicle manager 29 determines that a checkpoint has been passed, the vehicle manager 29 is configured to determine a time value indicating the time of day by analyzing vehicle clock 38, and the vehicle manager 29 is configured to compare this time value with the time value in the schedule 39 associated with the checkpoint.

The vehicle 17 is considered to be off schedule if the value for the time of day from clock 38 differs from the time value in schedule 39 by a predetermined amount. Otherwise the vehicle 17 is considered to be on schedule. For example, assume that the vehicle 17 is to be considered off schedule if the vehicle 17 is early or late by more than two minutes and assume that the vehicle 17 is scheduled to pass a checkpoint at 6:30 a.m. If the vehicle 17 passes the checkpoint between 6:28 a.m. and 6:32 a.m., the vehicle 17 is on schedule. If the vehicle 17 passes the checkpoint before 6:28 a.m., the vehicle is off schedule and is early. If the vehicle 17 passes the checkpoint after 6:32 a.m., the vehicle 17 is off schedule and is late.

If the vehicle manager 29 determines that the vehicle 17 is off schedule, the vehicle manager 29 is configured to transmit a status message to a base station control unit (BSCU) 40 (FIG. 1) indicating how much the vehicle is off schedule, and the vehicle manager 29 is also configured to update the entries in the schedule 39. For example, assume that the vehicle 17 passes the aforementioned checkpoint at 6:25 a.m. In this example, the vehicle 17 is off schedule and five minutes early. Therefore, the vehicle manager 29 transmits a status message to BSCU 40 via cellular network 42 indicating that the vehicle 17 is five minutes early and decreases the expected times stored in the schedule 39 by five minutes. As a result, the schedule 39 is adjusted to account for the vehicle's earliness, and the vehicle 17 will not be deemed off schedule when the vehicle 17 passes the other checkpoints, provided that the rate of travel of the vehicle 17 continues as expected for the remainder of the route. Similarly, if the vehicle 17 passes the aforementioned checkpoint at 6:35 a.m., then the vehicle manager 29 is configured to transmit a status message indicating that the vehicle 17 is five minutes late and is configured to increase the times stored in the schedule 39 by five minutes.

It should be noted that updating the schedule 39 is not necessary in implementing the present invention. However, if the vehicle 17 is early or late at one checkpoint, the vehicle 17 will likely be respectively early or late at other checkpoints causing the vehicle manager 29 to make an off schedule determination and to transmit a status message at each of the remaining checkpoints in the route. By updating the times in schedule 39, the number of status messages transmitted to the BSCU 40 may be reduced in monitoring the travel of the vehicle 17.

It should be further noted that the status message transmitted by VCU 15 may be communicated via any suitable technique and that utilization of the cellular network 42 is not necessary. In this regard, other types of networks may be used to communicate the status message, or the status message may be communicated directly to the base station control unit 40 without the use of any type of communication network. For example, the status message may be communicated via short wave radio.

Base Station Control Unit

Referring to FIG. 4, the base station control unit (BSCU) 40 preferably comprises a master computer system 42 that controls one or more slave computer systems 44*a*, 44*b*, and 44*c*. Referring to FIG. 5, the master computer system 42 includes a route handler 52 and a schedule monitor 56. The route handler 52 and schedule monitor 56, which will be described in further detail hereafter, can be implemented in software, hardware, or a combination thereof. Preferably, as illustrated by way of example in FIG. 5, the route handler 52 and schedule monitor 56 of the present invention along with their associated methodology are implemented in software and stored in memory 58.

Further shown by FIG. 5, the computer system 42 may include one or more processing elements 61, such as a DSP, that communicate to and drive the other elements within the system 42 via a local interface 62, which may include one or more buses. Furthermore, an input device 64, for example, a keyboard or a mouse, can be used to input data from a user of the system 42, and screen display 65 or a printer 66 can be used to output data to the user. A disk storage mechanism 69 can be connected to the local interface 62 to transfer data to and from a nonvolatile disk (e.g., magnetic, optical, etc.). Furthermore, a base station clock 70 may be connected to the computer system 42 so that components of the system 42 may utilize data from the clock 70 to determine time through conventional techniques. The system 42 may also be connected to a cellular interface 71, or other type of suitable interface, for communicating with VCU 15. It may also be desirable for computer system 42 to include a network interface 72 that allows the system 42 to exchange data with a network 73. It should be noted that input device 64, display 65, printer 66, disk 69, network interface 72, and network 73 are optional and are not necessarily a part of the preferred embodiment.

Referring again to FIG. 4, the database **74** shown by FIG. 4 preferably stores data defining the routes of one or more vehicles **17**. For example, the database **74** may include entries that are correlated with a vehicle **17** of the system **10**, wherein each entry includes sufficient data to define a checkpoint that may be used to monitor the travel of the vehicle **17**. The checkpoints defined in the database **74** for a particular vehicle **17** are preferably the same checkpoints defined in vehicle schedule **39** for the particular vehicle **17**. Furthermore, the entry may also include data to indicate the time of day that the vehicle **17** is expected to reach the checkpoint defined by the entry. Therefore, the database **74** includes sufficient data to define the checkpoints used to monitor the vehicles **17** associated with the system **10** and the times that the vehicles **17** should respectively pass the checkpoints.

Preferably, the database **74** also includes data indicating when different users are to be notified of an impending arrival of at least one of the vehicles **17** associated with the system **10**. For example, the database **74** may include data indicating that a user should be notified a certain amount of time before or after a particular vehicle **17** passes a particular checkpoint. Therefore, at any time, the database **74** can be queried to determine which checkpoints are to be passed by a particular vehicle **17** and when the particular vehicle **17** is expected to pass each of the checkpoints. The database **74** also can be queried to determine when users are to be notified of the particular vehicle's impending arrival. To facilitate querying of the database, the entries of the database **74** may be keyed by vehicle numbers used to identify the vehicles associated with the system **10**.

To illustrate the configuration and use of the database **74**, assume that a user would like to be notified when a particular vehicle **17** is two minutes from a particular location, such as the user's house or a scheduled vehicle stop. Assume further that the vehicle **17** is scheduled to pass a checkpoint every five minutes after starting its route and that the particular location is expected to be reached seventeen minutes after the vehicle **17** starts its route. In this scenario, the database **74** should include data that defines each of the checkpoints along the vehicle's route and that indicates the time that the vehicle **17** is expected to pass each of the checkpoints. The database **74** should also indicate that the individual is to be notified when the vehicle **17** passes the third checkpoint, since the vehicle **17** is expected to pass the third checkpoint fifteen minutes into the route (i.e., two minutes before the vehicle **17** is expected to reach the particular location).

The database **74** also preferably includes sufficient information to enable the individual to be automatically notified once a determination is made that the user should be notified. For example, the database **74** may include the individual's telephone number, pager number, e-mail address, or other type of contact information, depending on the methodology used to notify the individual.

The route handler **52** (FIG. 5) is configured to query the database **74** to build a list of notification events that are expected to occur during a specified time period. A "notification event" is the generation of a notification message to be transmitted to a user to notify the user of an impending arrival of a vehicle **17** associated with the system **10**. For example, the route handler **52** may query the database **74** at the beginning of a day to determine each notification event that should occur during the course of the day, and the route handler **52** then builds a list of these events. The list should not only indicate what notification events are to occur but also should indicate at what time each notification event is expected to occur. The list may also include contact information (e.g., telephone numbers, pager numbers, e-mail addresses etc.) to facilitate the process of contacting the users associated with the notification events in the list.

FIG. 6 shows an exemplary list **81** that may be produced by the route handler **52**. The list **81** depicts four entries, although any number of entries may be included in the list **81**. Each entry of the list **81** is associated with a respective notification event and indicates: (1) the time at which the respective notification event is expected to occur, (2) the contact information (e.g., telephone number, pager number, e-mail address etc.) associated with the particular user, and (3) a vehicle number identifying the particular vehicle **17** associated with the notification event. For example, assume that "entry 1" is associated with a notification event for a user that would like to be notified when a particular vehicle (vehicle number "1112") is five minutes from a particular location. Based on the information stored in database **74**, assume that the route handler **52** determines that the notification event should occur at 6:30 a.m. (five minutes before the particular vehicle **17** is scheduled to arrive at the particular location). As a result, "entry 1" of the list **81** indicates that the notification event associated with the entry is to occur at 6:30 a.m. "Entry 1" also provides the user's contact information and the vehicle number ("1112") of the vehicle **17** that is to arrive at the particular location. Each of the other entries can be similarly configured based on the information associated with the notification events associated with the other entries. Once the route handler **52** has defined the list **81**, the route handler **52** transmits the list **81** to schedule monitor **56**.

When the BSCU **40** receives a status message from one of the VCUs **15** indicating that one of the vehicles **17** is early or late, the route handler **52** transmits an update request based on the received status message. In response to the update request, the schedule monitor **56** is designed to update the list **81**, if the list **81** includes an entry associated with a notification event pertaining to the one vehicle **17**.

For example, assume that the route handler **52** receives a status message indicating that the vehicle **17** associated with "entry 1" (i.e., vehicle number "1112") is seven minutes late. In response, the route handler **52** transmits an update request to schedule monitor **56**. The update request preferably includes information indicating which vehicle **17** is off schedule and how much the vehicle **17** is off schedule. Based on this update request, the schedule monitor **56** determines that the vehicle **17** associated with the update request (i.e., vehicle number "1112") is seven minutes late. The schedule monitor **56** is designed to traverse the list **81** to identify each entry associated with the vehicle number "1112" and is configured to increase the time values stored in the identified entries by seven minutes to account for the tardiness of vehicle number "1112." Therefore, in the list **81** depicted by FIG. 6, the schedule monitor **56** changes the time value in "entry 1" from "6:30" to "6:37." As a result, the notification event associated with "entry 1" should not occur until 6:37 a.m.

Upon receiving a status message, the route handler **52** is also designed to update the database **74**. Therefore, in the example described hereinbefore, the route handler **52** is designed to input data into the database **74** indicating that vehicle number "1112" is seven minutes late. As a result, the database **74** can be consulted at any time to determine not only the scheduled route of any vehicle **17** but also to determine the status of the vehicle **17** as the vehicle **17** is traveling its route. In this regard, if the database **74** does not indicate that a particular vehicle **17** is early or late, then it can be assumed that the vehicle **17** should arrive at its future

checkpoints on schedule. However, if the database **74** indicates that the vehicle **17** is early or late, then it can be assumed that the vehicle **17** will arrive at its future checkpoints off schedule by the amount indicated by the database **74**.

The schedule monitor **56** is configured to periodically scan the list **81** to determine if a notification event should occur (i.e., if a notification message should be transmitted to a user). In this regard, when the time of the day, as determined from base station clock **70**, corresponds to (e.g., matches) the time indicated by one of the entries in the list **81**, the schedule monitor **56** determines that the notification event associated with the corresponding entry should occur. Therefore, to initiate the occurrence of the notification event, the schedule monitor **56** is designed to transmit a notification request to one of the slave computers **44a–44c**, which transmits a notification message in response to the notification request, as will be described in more detail hereinbelow.

As shown by FIG. **4**, a switching mechanism **85**, such as an etherswitch, for example, is used to route the notification request to the appropriate slave computer **44a–44c**. In an attempt to balance the workload of the slave computers **44a–44c**, the schedule monitor **56** preferably selects one of the slave mechanisms **44a–44c** to process the notification request based on the number of notification requests previously transmitted to each slave computer **44a–44c** within a specified time period. For example, the schedule monitor **56** could be configured to transmit the notification message to the slave computer **44a–44c** that has received the least number of notification requests in the last five minutes. As a result, the workload of the slave computers **44a–44c** is not likely to become disproportionately high for any one of the slave computers **44a–44c**.

As shown by FIG. **7**, each of the slave computers **44a–44c** includes a communication handler **92** configured to process each notification request received by the computer **44a–44c**. The communication handler **92** may be implemented in software, hardware, or a combination thereof. Preferably, as depicted by FIG. **7**, the communication handler **92** is implemented in software and stored in memory **95**.

Further shown by FIG. **7**, each slave computer system **44a–44c** may include one or more processing elements **97**, such as a DSP, that communicate to and drive the other elements within the system **44a–44c** via a local interface **99**, which may include one or more buses. Furthermore, the base station clock **70** may be connected to each computer system **44a–44c** so that components of the system **44a–44c** may utilize data from the clock **70** to determine time through conventional techniques. Each slave computer **44a–44c** preferably includes an interface **115**, such as a telephone interface, for example, coupled to a plurality of communication connections **119** that enables the communication handler **92** to transmit the notification messages across the connections **119**. As an example, the interface **115** may be coupled to a T1 trunk or a plurality of T1 trunks that, as known in the art, are capable of placing up to twenty-four telephone calls each.

The communication handler **92** is preferably capable of processing multiple notification requests and of simultaneously communicating multiple notification messages to users to warn the users of impending arrivals of vehicles **17**. For example, in one embodiment, the communication handler **92** is implemented by a D/240PCI card **111** manufactured by Dialogic Corp., as shown by FIG. **8**. Other software **113** may be implemented to interface the notification messages with the Dialogic card. This other software **113** may include Visual Voice software, which is a well known set of software commonly used to interface data with the Dialogic card **111**.

As shown by FIG. **1**, the notification messages may be routed to one or more users via a communication network, such as the publicly switched telephone network (PSTN) **123**. In this regard, the network **123** routes each notification message transmitted by a communication handler **92** to a communication device **124**, such as a telephone, for example, at a premises **126** of a user that is to receive the notification message. Upon receiving the notification message from network **123**, the communication device **124** communicates the notification message to the user. It should be noted that the notification messages do not necessarily have to be communicated via telephone calls and that the communications device **124** may be any device capable of communicating a notification message. For example, the communications device **124** may be pager in one embodiment. In another embodiment, the communication handler **92** transmits a notification message to the device **124** via the Internet. For example, the communication handler **92** may transmit an e-mail message to the device **124**, which in this example is a computer capable of reading the message and displaying the message to the user.

If a notification request cannot be immediately serviced by the communication handler **92**, then the communication handler **92** is designed to store the notification request into a queue **121**. The communication handler **92** then services the notification requests stored in the queue **121** on a first in, first out (FIFO) basis. Therefore, the communication handler **92** of each system **44a–44c** services the notification requests in the order in which they were received by the communication handler **92**.

As stated hereinbefore, each notification request is generated in response to a determination that a user should be warned of an impending arrival of a particular vehicle **17** at a particular location. Therefore, each notification request preferably includes contact information to enable the communication handler **92** to send a notification message to the particular user associated with the notification request or includes other information to enable the communication handler **92** to retrieve such contact information from the database **74**. As a result, the communication handler **92** is configured to utilize contact information included in the notification request or stored in the database **74** to transmit a notification request to the user associated with the notification request.

It should be noted that it is possible for the notification message to be user specific. For example, the message may include the phrase "Vehicle number 1112 is five minutes from your vehicle stop." To enable such a message, the vehicle number and the time from the user's stop may be included in the notification request. Therefore, each entry in the list **81** may include, in addition to the information shown in FIG. **6**, the amount of time that the vehicle **17** is from the user's selected destination when the notification event associated with the entry is expected to occur.

Furthermore, since there may be a delay between generating a notification request and in servicing the notification request, the communication handler **92** may be designed to query the database **74** to update the notification message before transmission. For example, if the notification request is generated when the vehicle **17** is five minutes from a user's selected destination and if the notification message is transmitted two minutes later, the communication handler **92** can be designed to query the database **74** based on the information provided in the notification request and determine that two minutes have elapsed since the notification request was generated. Therefore, the communication handler **92** may modify the message to include the phrase "Vehicle 1112 is three minutes from your vehicle stop."

It should be further noted that the list **81** is not a necessary feature of the present invention. In this regard, the database **74** can be repeatedly searched to determine when to generate notification requests. However, repeatedly searching the database **74** could result in the unnecessary processing of a vast amount of data, depending on the amount of data and entries stored in database **74**. Utilization of the list **81** enables a much smaller amount of data to be searched in identifying whether notification requests should be generated.

Furthermore, it is not necessary for the communication handlers **92** to be implemented by slave computers **44*a*–44*c***. For example, it may be possible to implement the route handler **52**, the schedule monitor **56**, and the communication handlers **92** in a single computer system, such as system **42**. In addition, the present invention has been described as using three communication handlers **92** for the purposes of illustration only, and any number of communication handlers **92** (i.e., one or more) may be utilized by the system **10**.

In addition, it is possible to use the contents of the database **74** to create a web page indicating the status of the vehicles **17** associated with the system **10**. Therefore, users can access the web page via the Internet or some other suitable communication network to determine whether a particular vehicle **17** is on or off schedule and how much a particular vehicle may be off schedule.

Furthermore, as shown by FIG. **4**, the slave computers **44*a*–44*c*** can be connected to one another and can be configured to reallocate notification requests. For example, the communication handlers **92** in the slave computers **44*a*–44*c*** can be configured to communicate to one another how many notification requests are currently queued by each of the communication handlers **92**. If the difference in the number of notification requests queued by one communication handler **92** and the number of notification requests queued by another communication handler **92** exceeds a predetermined threshold, then the communication handler **92** having the higher number of queued notification requests preferably transmits one or more of the queued notification requests to the other communication handler **92**. Therefore, the occurrence of one communication handler **92** having a disproportionately high number of queued notification requests should be prevented.

It should be noted that there are many alternative embodiments that may be implemented to reallocate the notification requests without departing from the principles of the present invention. For example, in one embodiment, a first communication handler **92** may be designed to communicate a reallocation request to one or more of the other communication handlers **92** when the number of notification requests queued by the first communication handler falls below a predetermined threshold. In response to the reallocation request, at least one of the other communication handlers **92** transmits one or more of its queued notification requests to the first communication handler **92**, which services the notification request. Other variations for reallocating the notification requests are possible.

In other embodiments, it may be possible for the VCU **15** to transmit notification requests directly to the communication device **124** at the user's premises **126**. Such a system is fully described in U.S. Pat. No. 5,444,444 entitled "Apparatus and Method of Notifying a Recipient of an Unscheduled Delivery" and filed on Sep. 16, 1994, by Ross, which is incorporated herein by reference.



Alternative Embodiments

It should be noted that there are many alternative embodiments for implementing the vehicle tracking system **10**. For example, in one alternative embodiment, portions of the schedule monitor **56** are implemented in each of the slave computers **44*a*–44*c***. When implemented in software, the schedule monitor **56** in each slave computer **44*a*–44*c*** may be stored in the memory **95** of the slave computer **44*a*–44*c***.

In this example, a list **81** of notification events is created by the route handler **52** in the master computer **42**, as described hereinabove. However, portions (e.g., entries) of the list **81** are transmitted to each slave computer **44*a*–44*c***, which monitors the received portion of the list **81**. For example, once the list **81** is created by the route handler **52**, the route handler **52** is designed to assign certain vehicles **17** to certain ones of the slave computers **44*a*–44*c***. The route handler **52** is designed to then transmit each entry defining a notification event associated with a particular vehicle **17** to the slave computer **44*a*–44*c*** assigned to the particular vehicle **17**. The assignment of the vehicles **17** to the slave computers **44*a*–44*c*** is preferably controlled by the route handler **52** such that each slave computer **44*a*–44*c*** receives a similar number of notification events in an effort to prevent any one slave computer **44*a*–44*c*** from becoming overburdened.

The schedule monitor **56** in each slave computer **44*a*–44*c*** then builds a notification event list **81** including each of the entries received by the slave computer **44*a*–44*c***. As a result, the functionality of monitoring the list **81** is divided across the slave computers **44*a*–44*c***. Moreover, when a status message from a VCU **15** is received by cellular interface **71**, the route handler **52** in the master computer **42** is designed to determine which slave computer **44*a*–44*c*** is assigned to the vehicle **17** associated with the status message. Then, the route handler **52** of the slave computer **42** is designed to transmit the status message to the slave computer **44*a*–44*c*** assigned to the foregoing vehicle **17**. The schedule monitor **56** in the slave computer **44*a*–44*a*** receiving the status message then updates the list **81** maintained in the slave computer **44*a*–44*c***, via techniques described hereinbefore.

The schedule monitor **56** in each slave computer **44*a*–44*c*** monitors the list **81** in the same slave computer **44*a*–44*c*** to determine when a notification event should occur. When a notification event occurs, the schedule monitor **56** transmits a notification request to the communication handler **92**, which processes the notification as described hereinbefore. Therefore, the operation of the foregoing embodiment is similar to the embodiment previously described, except that at least some of the functionality of the schedule monitor **56** is implemented in each of the slave computers **44*a*–44*c***. Dividing the functionality of the schedule monitor **56** across multiple slave computers **44*a*–44*c*** is advantageous in applications utilizing a relatively large number of notification events, since monitoring of a large number of notification events by the master computer **42** may overload the master computer **42**.

## Operation

The preferred use and operation of the system **10** and associated methodology are described hereafter.

Initially, a vehicle schedule **39** is respectively stored in the VCU **15** of each vehicle **17** associated with the system **10**. As set forth hereinbefore, the vehicle schedule **39** includes data defining a plurality of checkpoints along the vehicle's route or routes of travel and the expected time that the vehicle **17** is to pass each of the checkpoints. There are a variety of methodologies that may be employed to determine the information stored in the VCU **15**. In one embodiment, the data is accumulated from the sensor **18** and the vehicle clock **38**, as the vehicle **17** travels the route or routes. Such a methodology is described in more detail in U.S. patent application entitled "Apparatus and Method for Monitoring Travel of a Mobile Vehicle," assigned Ser. No. 09/395,497, and filed on Sep. 14, 1999, which is incorporated herein by reference.

The route data stored in vehicle schedule **39** is also stored in database **74** of BSCU **40**. Furthermore, contact information associated with each user that is to be notified of an impending arrival of one of the vehicles **17** is also stored in database **74** so that the users may be sent a notification message at appropriate times. Each user is allowed to select a vehicle **17** and a time when the user would like to be warned of an impending arrival of the selected vehicle **17**. The process of enabling a user to select a vehicle and a time is further described in U.S. patent application entitled "System and Method for Activation of an Advance Notification System for Monitoring and Reporting Status of Vehicle Travel," assigned Ser. No. 09/163,588, and filed on Sep. 30, 1998, which is incorporated herein by reference.

As shown by blocks **205** and **207** of FIG. **9**, the route handler **52** builds a list **81** of notification events that should occur during a specified time period and transmits this list **81** to schedule monitor **56**. For illustrative purposes, assume that the user selects to receive a notification message when a particular vehicle **17** is five minutes from a particular location. Further assume that the vehicle **17** is scheduled to arrive at the particular location at 6:35 a.m., which is within the aforementioned specified time period. As a result, the user should receive a notification message at 6:30 a.m., if the vehicle **17** is on schedule when traveling the route, and in performing block **205**, the route handler **52** defines an entry in the list **81** indicating that the user should be so notified at 6:30 a.m. "Entry 1" of the list **81** depicted by FIG. **6** is suitable for implementing the present invention in the context of the foregoing example.

At some point, the vehicle **17** begins to travel its route. Before or during travel of the route, the vehicle clock **38** should be synchronized with the BSCU clock **70**. As vehicle **17** travels its route, it passes checkpoints, and its VCU **15** monitors its progress. In this regard, based on the signals provided by sensor **18**, the VCU **15** determines when vehicle **17** passes each of its checkpoints, as shown by blocks **211**, **213**, and **215** of FIG. **10**. As depicted by blocks **218** and **222**, when vehicle **17** passes a checkpoint, the VCU **15** determines whether the vehicle **17** is on or off schedule by comparing the current time, as defined by vehicle clock **38**, with the time value associated with the passed checkpoint and stored in vehicle schedule **39**.

If vehicle **17** is determined to be off schedule, then the VCU **15** transmits a status message to BSCU **40** indicating how much the vehicle **17** is off schedule and updates the time values associated with the remaining checkpoints (i.e., the checkpoints that have yet to be passed by vehicle **17**), as shown by blocks **225** and **227**. As depicted by block **229**, the VCU **15** continues to monitor the progress of vehicle **17** until vehicle **17** passes the last checkpoint on the route.

Upon receiving a status message from the VCU **15**, the route handler **52** updates the database **74** to indicate that the vehicle **17** is off schedule by an amount indicated by the status message, as depicted by blocks **235** and **239** of FIG. **9**. Next, as shown by block **242**, the route handler **52** transmits an update request to the schedule monitor **56** indicating that the vehicle **17** associated with the status message is off schedule by a specified amount (e.g., a specified number of minutes early or late). As shown by block **245**, the route handler **52** continues to check for status messages until each notification event in the list **81** has occurred.

As shown by blocks **252** and **255** of FIG. **11**, the schedule monitor **56** updates the list **81** when the schedule monitor **56** receives an update request from route handler **52**. In this regard, when the schedule monitor **56** receives an update request indicating that a vehicle **17** is off schedule, the schedule monitor **56** changes the time values in the entries associated with the vehicle **17** by an amount that the vehicle **17** is off schedule.

As depicted by block **261**, the schedule monitor **56** periodically checks to determine whether any notification events should occur. In this regard, the schedule monitor **56** compares the current time, as determined by the BSCU clock **70**, with the time values in the list **81**. If the time value of an entry in the list **81** corresponds with the current time (e.g., matches the current time, in the preferred embodiment), then the schedule monitor **56** determines that a notification message should be transmitted to a user to warn the user of an impending arrival of the vehicle **17** associated with the entry. Therefore, in block **264**, the schedule monitor **56** transmits a notification request to one of the communication handlers **92** indicating that a user should be notified. The notification request preferably includes data identifying the user (such as the user's telephone number, pager number, e-mail address, or any other value unique to the user) and identifying the vehicle **17** associated with the notification event. As shown by block **268**, the schedule monitor **56** continues to monitor the entries in the list **81** until each notification event defined by the entries has occurred.

As shown by blocks **275** and **277** of FIG. **12**, each communication handler **92** places any new notification request received from schedule monitor **56** into a respective queue. As depicted by blocks **281** and **284**, each communication handler **92** determines whether a new call can be initiated via interface **115** and initiates transmission of a notification message if the interface **115** can handle a new call. In this regard, the communication handler **92** uses the information in the notification request to identify the user that should be notified by the notification message. The information in the notification request may either include the contact information needed to establish communication with the user or the communication handler **92** may look up the contact information in the database **74**.

Furthermore, the notification message may provide a status report for the vehicle **17** associated with the notifica-

tion request. For example, the notification message may indicate that the vehicle **17** is a certain number of minutes from a particular location. The communication handler **92** may retrieve information from the database **74** to form the notification message. By retrieving the information for the status report directly from the database **74**, the communication handler **92** utilizes the most recent information available in providing any status reports to the user.

If the interface **115** cannot handle a new call (e.g., the interface **115** is not operating properly or there are no available communication lines **119**) the communication handler **92** preferably checks to see if another communication handler **92** has a disproportionately less number of notification requests queued, as shown by block **288**. If the difference in the number of queued notification requests in the two communication handlers **92** being compared in block **288** exceeds a predetermined threshold, then the communication handler **92** reallocates the queued notification requests by transmitting one or more of its queued notification requests to the other communication handler **92** that has a smaller number of queued notification requests, as depicted by blocks **292** and **295**. Ultimately, a notification message is transmitted by one of the communication handlers for each notification request transmitted by the schedule monitor **56**.

It should be noted that the present invention has been described herein as determining when to initiate a notification message to a user based on a time value. However, other types of values may be used to monitor the travel of the vehicle **17**. For example, a notification message could be initiated when a particular vehicle comes within a certain distance of a particular location. U.S. patent application entitled "Base Station Apparatus and Method for Monitoring Travel of a Mobile Vehicle," assigned Ser. No. 09/395,501, and filed on Sep. 14, 1999, which is incorporated herein be reference, describes how distance values may be used to determine when to transmit notification messages.

It should be emphasized that the above-described embodiments of the present invention, particularly, any "preferred" embodiments, are merely possible examples of implementations, merely set forth for a clear understanding of the principles of the invention. Many variations and modifications may be made to the above-described embodiment(s) of the invention without departing substantially from the spirit and principles of the invention. All such modifications and variations are intended to be included herein within the scope of the present invention and protected by the claims.

Now, therefore, the following is claimed:

**1.** A system for notifying users of impending arrivals of vehicles at particular locations, comprising:

memory storing a first time value, said first time value indicating when a user should be notified of an impending arrival of a vehicle;

a clock configured to produce a second time value;

a route handler configured to receive a status message from said vehicle and to transmit an update request when said vehicle is off schedule based on said status message;

a schedule monitor configured to compare said first time value to said second time value and to produce and transmit a notification request based on a comparison of said time values, said schedule monitor further configured to update said first time value in response to said update request; and

a communication handler configured to receive said notification request and to transmit a notification message to said user in response to said notification request, said communication handler further configured to store said notification request and to determine a number of notification requests stored by said communication handler, said communication handler further configured to compare said number of notification requests to a threshold number and to cause reallocation of notification requests between said communication handler and at least one other communication handler based on a comparison of said number of notification requests to said threshold number.

**2.** The system of claim **1**, wherein said communication handler receives a notification request in response to said reallocation.

**3.** The system of claim **1**, wherein said communication handler transmits a notification request in response to said reallocation.

**4.** The system of claim **1**, wherein said threshold number is a number of notification requests stored in another communication handler.

**5.** The system of claim **1**, wherein said communication handler is configured to simultaneously transmit a plurality of notification messages across a plurality of communication lines.

**6.** The system of claim **1**, further comprising:

a database storing route information associated with a plurality of vehicles, said route information including said first time value,

wherein said route handler is configured to determine whether said first time value is associated with a notification event that is expected to occur within a particular time period and to transmit said first time value to said schedule monitor in response to a determination that said notification event associated with said first time value is expected to occur within said particular time period.

**7.** The system of claim **1**, wherein said route handler is further configured to produce a list of notification events that are expected to occur within a particular time period, said route handler further configured to include said first time value in said list in response to a determination that said first time value is associated with a notification event that is expected to occur within said particular time period, said schedule monitor further configured to analyze said list to determine whether any notification requests should be transmitted to said communication handler.

**8.** The system of claim **1**, wherein said schedule monitor is implemented within a first computer system and said communication handler is implemented within a second computer system.

**9.** A system for notifying users of impending arrivals of vehicles at particular locations, comprising:

a database storing data associated with a plurality of vehicles;

a route handler configured to analyze said data and to select portions of said data that are associated with notification events expected to occur during a particular time period;

a schedule monitor configured to analyze said selected portions of said data during said particular time period and to disregard other portions of said data during said particular time period, said schedule monitor further configured to determine when at least one of said notification events should occur based on said selected portions of said data and to transmit a notification request in response to a determination by said schedule monitor that said at least one notification event should occur; and

a communication handler configured to receive said notification request and to transmit a notification message in response to said notification request.

**10**. The system of claim **9**, wherein said communication handler is configured to simultaneously transmit a plurality of notification messages across a plurality of communication lines.

**11**. The system of claim **9**, wherein said communication handler is configured to store said notification request and to determine a number of notification requests stored by said communication handler, said communication handler further configured to compare said number of notification requests to a threshold number and to cause reallocation of notification requests between said communication handler and at least one other communication handler based on a comparison of said number of notification requests to said threshold number.

**12**. The system of claim **9**, wherein said schedule monitor is implemented in a first computer system and said communication handler is implemented in a second computer system.

**13**. A system for notifying users of impending arrivals of vehicles at particular locations, comprising:

memory storing data indicating a proximity of at least one vehicle to at least one location;

a route handler configured to receive status messages and to update said data based on said status messages;

a schedule monitor configured to monitor said data and to transmit notification requests in response to determinations by said schedule monitor that said at least one vehicle is within a predefined proximity of at least one location; and

a plurality of communication handlers configured to respectively receive said notification requests and to transmit notification messages in response to said notification requests,

wherein said schedule monitor is further configured to determine a number of notification requests transmitted to one of said communication handlers within a first particular time period and to allocate said notification requests between said communication handlers based on said number.

**14**. The system of claim **13**, wherein at least one of said communication handlers is configured to store notification requests and to determine a number of notification requests stored by said at least one communication handler, said at least one communication handler further configured to compare said number of notification requests to a threshold number and to cause reallocation of notification requests between said communication handler and another of said communications handlers based on a comparison of said number of notification requests to said threshold number.

**15**. The system of claim **13**, wherein said route handler selects said data in response to a determination by said route handler that said data is associated with notification events that are expected to occur during a second particular time period.

**16**. A method for notifying users of impending arrivals of vehicles at particular locations, comprising the steps of:

storing a first time value, said first time value indicating when a user should be notified of an impending arrival of a vehicle;

receiving a second time value;

receiving a status message transmitted from said vehicle;

updating said first time value based on said status message;

comparing said first time value to said second time value;

transmitting a notification request to a communication handler based on said comparing said first time value step;

determining a number of notification requests stored by a communication handler;

comparing said number of notification requests to a threshold number;

reallocating said notification request between said communication handlers based on said comparing said number of notification requests step; and

transmitting a notification message to said user in response to said notification request.

**17**. The method of claim **16**, further comprising the steps of:

determining whether said first time value indicates a time within a particular time period, said particular time period including a time indicated by said second time value; and

performing said comparing said first time value step during said particular time period in response to a determination in said determining step that said first time value indicates a time within said particular time period.

**18**. The method of claim **16**, further comprising the steps of:

creating a list of notification events that are expected to occur within a particular time period;

including said first time value in said list in response to a determination that said first time value is associated with a notification event that is expected to occur within said particular time period; and

monitoring said list during said particular time period, said monitoring step including said comparing said first time value step.

**19**. A method for notifying users of impending arrivals of vehicles at particular locations, comprising the steps of:

storing data associated with a plurality of vehicles;

selecting portions of said data that are associated with notification events expected to occur during a particular time period;

analyzing said selected portions of said data during said particular time period;

disregarding other portions of said data during said particular time period;

determining when at least one of said notification events should occur based on said analyzing step; and

transmitting a notification message in response to said determining step.

**20**. A method for notifying users of impending arrivals of vehicles at particular locations, comprising the steps of:

storing data associated with at least one vehicle;

receiving at least one status message from said one vehicle;

updating said data based on said one status message;

analyzing said data;

determining when to notify a user of an impending arrival of said one vehicle at a particular location based on said analyzing step;

transmitting a notification request based on said determining step; and

allocating said notification request to a communication handler based on a number of notification requests transmitted to said communication handler during a first particular time period.

**21**. The method of claim **20**, further comprising the step of transmitting a notification message from said communication handler in response to said notification request, said notification message indicating said impending arrival of said one vehicle.

**22**. The method of claim **20**, further comprising the steps of:

storing said notification request in said communication handler;

determining a number of notification requests stored in said communication handler;

comparing said number of notification requests to a threshold number;

transmitting said notification request to another handler based on said comparing step; and

transmitting a notification message from said other communication handler in response to said notification request, said notification message indicating said impending arrival of said one vehicles.

**23**. The method of claim **20**, further comprising the step of selecting said data in response to a determination that said data is associated with notification events that are expected to occur during a second particular time period.

* * * * *

# EXHIBIT B

US007030781B2

(12) **United States Patent**
**Jones**

(10) **Patent No.: US 7,030,781 B2**
(45) **Date of Patent: *Apr. 18, 2006**

(54) **NOTIFICATION SYSTEM AND METHOD THAT INFORMS A PARTY OF VEHICLE DELAY**

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(73) Assignee: **ArrivalStar, Inc.**, Delray Beach, FL (US)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 24 days.

This patent is subject to a terminal disclaimer.

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**Related U.S. Application Data**

(63) Continuation of application No. 09/992,817, filed on Nov. 6, 2001, now Pat. No. 6,700,507, which is a continuation of application No. 09/233,795, filed on Jan. 19, 1999, now Pat. No. 6,313,760, which is a continuation of application No. 08/407,319, filed on Mar. 20, 1995, now abandoned, which is a continuation-in-part of application No. 08/063,533, filed on May 18, 1993, now Pat. No. 5,400,020.

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***G08G 1/123*** (2006.01)

(52) **U.S. Cl.** ...................... **340/994**; 340/989; 701/201; 701/213

(58) **Field of Classification Search** ................ 340/994, 340/988, 989; 379/59; 701/211, 117, 213, 701/201
See application file for complete search history.

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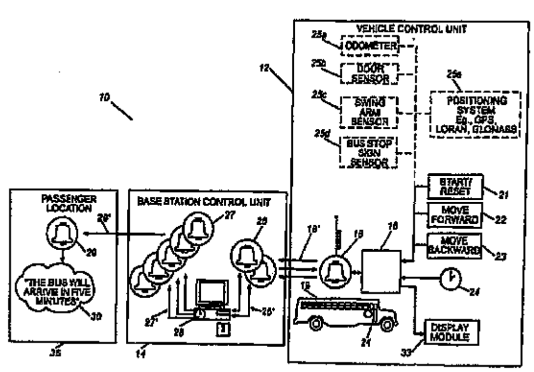
(57) **ABSTRACT**

An advance notification system and method notifies passengers of the impending arrival of a transportation vehicle, for example, a school bus, at a particular vehicle stop. The system generally includes an on-board vehicle control unit for each vehicle and a base station control unit for making telephone calls to passengers in order to inform the passengers when the vehicle is a certain predefined time period and/or distance away from the vehicle stop. The VCU compares elapsed time and/or traveled distance to the programmed scheduled time and/or traveled distance to determine if the vehicle is on schedule. If the vehicle is behind or ahead of schedule, the VCU calls the BSCU, which then adjusts its calling schedule accordingly.

**14 Claims, 7 Drawing Sheets**



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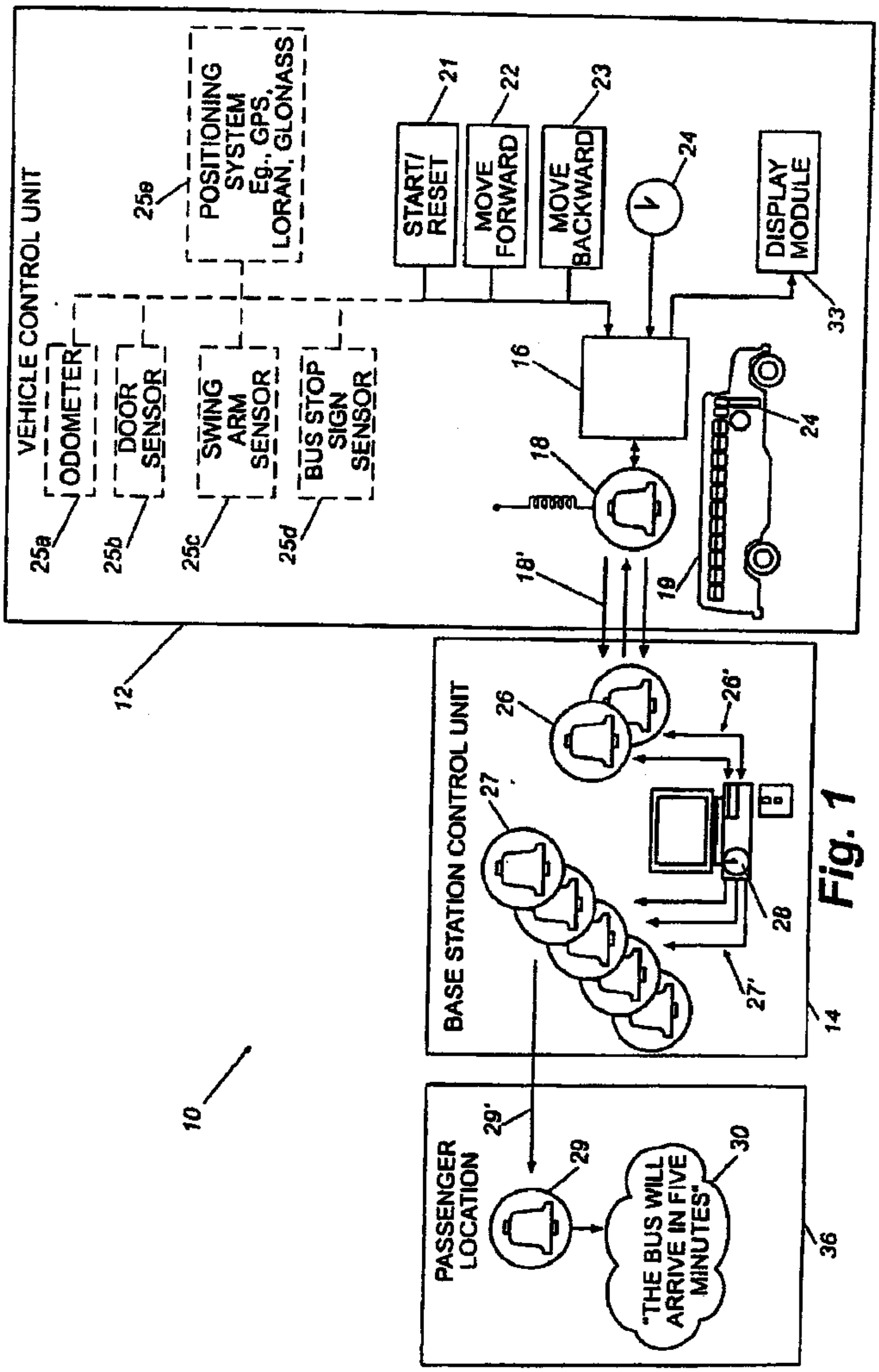

VEHICLE CONTROL UNIT
ODOMETER
DOOR SENSOR
SWING ARM SENSOR
BUS STOP SIGN SENSOR
POSITIONING SYSTEM Eg., GPS, LORAN, GLONASS
START/ RESET
MOVE FORWARD
MOVE BACKWARD
DISPLAY MODULE
BASE STATION CONTROL UNIT
PASSENGER LOCATION
"THE BUS WILL ARRIVE IN FIVE MINUTES"
25a
25b
25c
25d
25e
21
22
23
24
16
18
18'
19
33
12
26
26'
27
27'
28
14
10
29
29'
30
36

Fig. 1

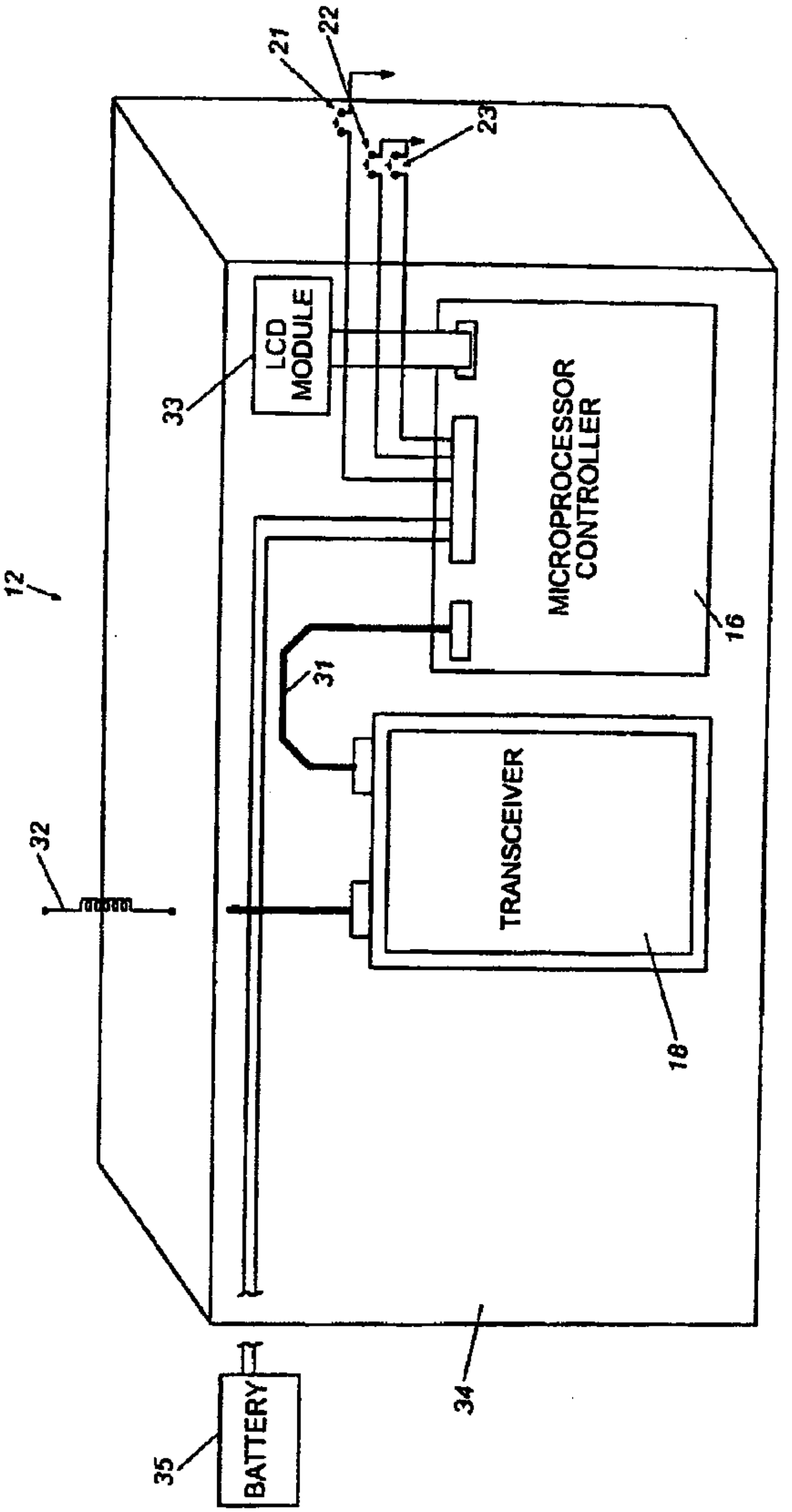

LCD MODULE
MICROPROCESSOR CONTROLLER
TRANSCEIVER
BATTERY
12
16
18
21
22
23
31
32
33
34
35

Fig. 2

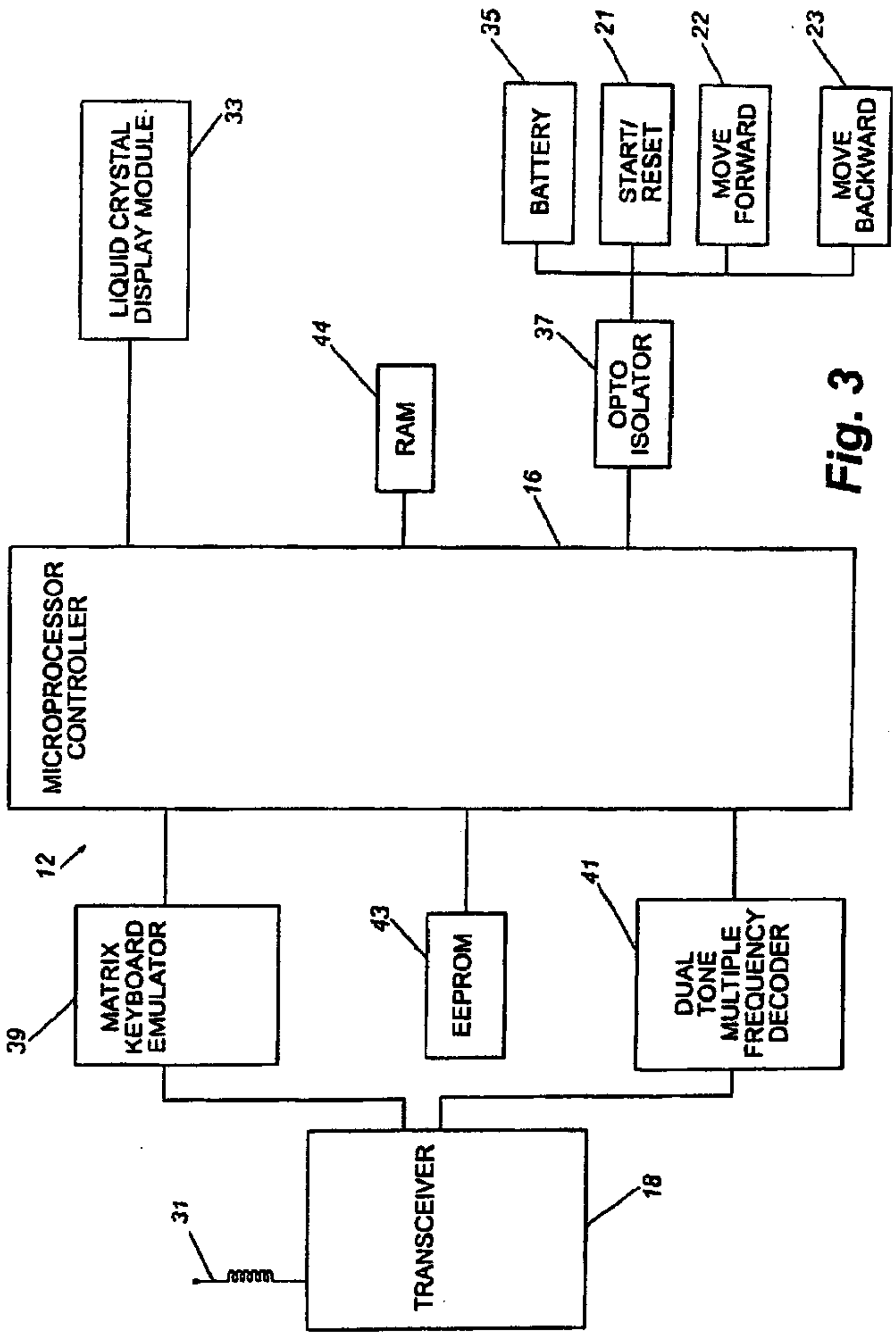

LIQUID CRYSTAL DISPLAY MODULE
33
BATTERY
35
START/ RESET
21
MOVE FORWARD
22
MOVE BACKWARD
23
RAM
44
OPTO ISOLATOR
37
16
MICROPROCESSOR CONTROLLER
12
MATRIX KEYBOARD EMULATOR
39
EEPROM
43
DUAL TONE MULTIPLE FREQUENCY DECODER
41
TRANSCEIVER
18
31

Fig. 3

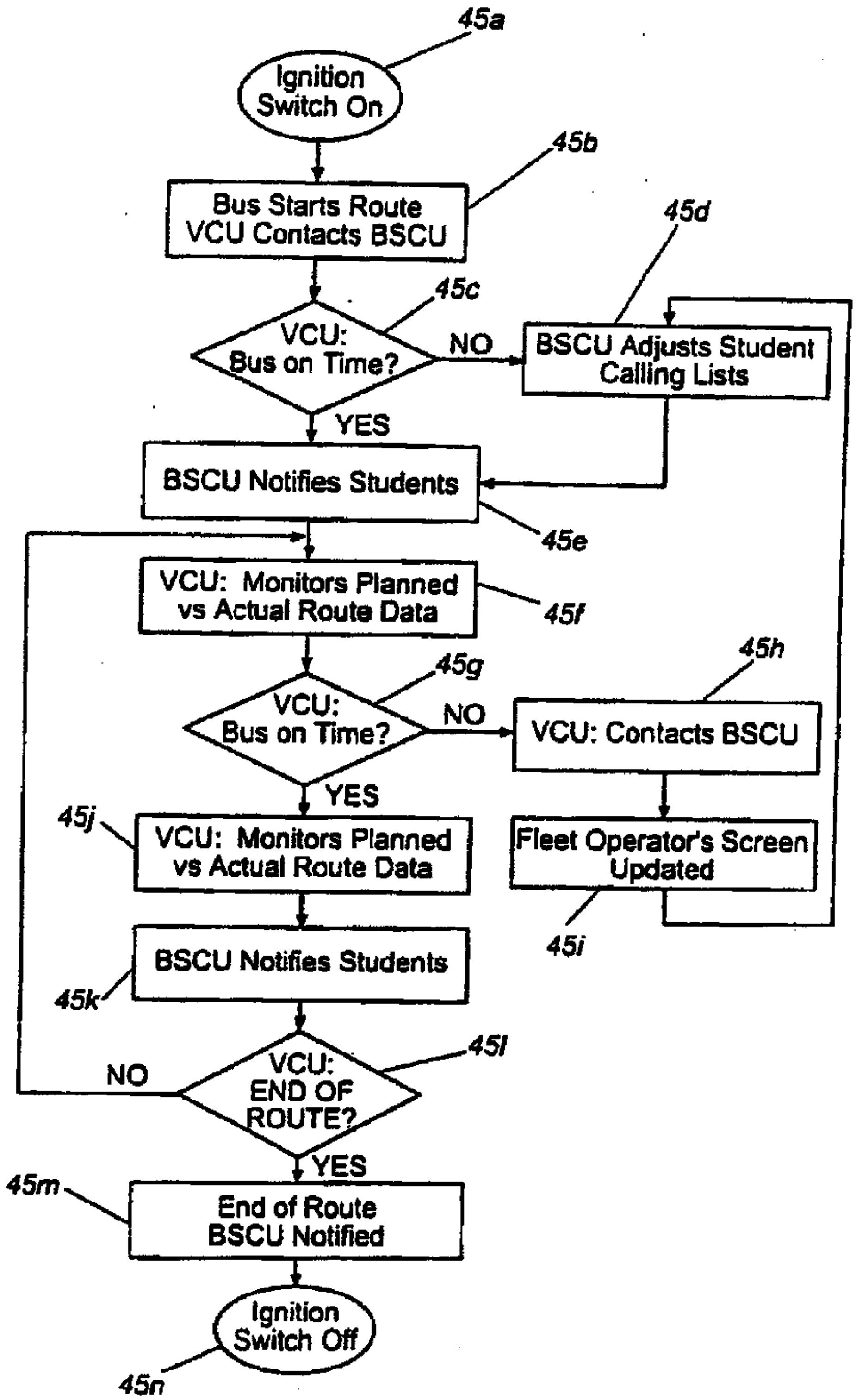

45a
Ignition Switch On
45b
Bus Starts Route VCU Contacts BSCU
45c
VCU: Bus on Time?
NO
45d
BSCU Adjusts Student Calling Lists
YES
BSCU Notifies Students
45e
VCU: Monitors Planned vs Actual Route Data
45f
45g
VCU: Bus on Time?
NO
45h
VCU: Contacts BSCU
YES
45j
VCU: Monitors Planned vs Actual Route Data
Fleet Operator's Screen Updated
45i
BSCU Notifies Students
45k
45l
NO
VCU: END OF ROUTE?
YES
45m
End of Route BSCU Notified
Ignition Switch Off
45n

*Fig. 4A*

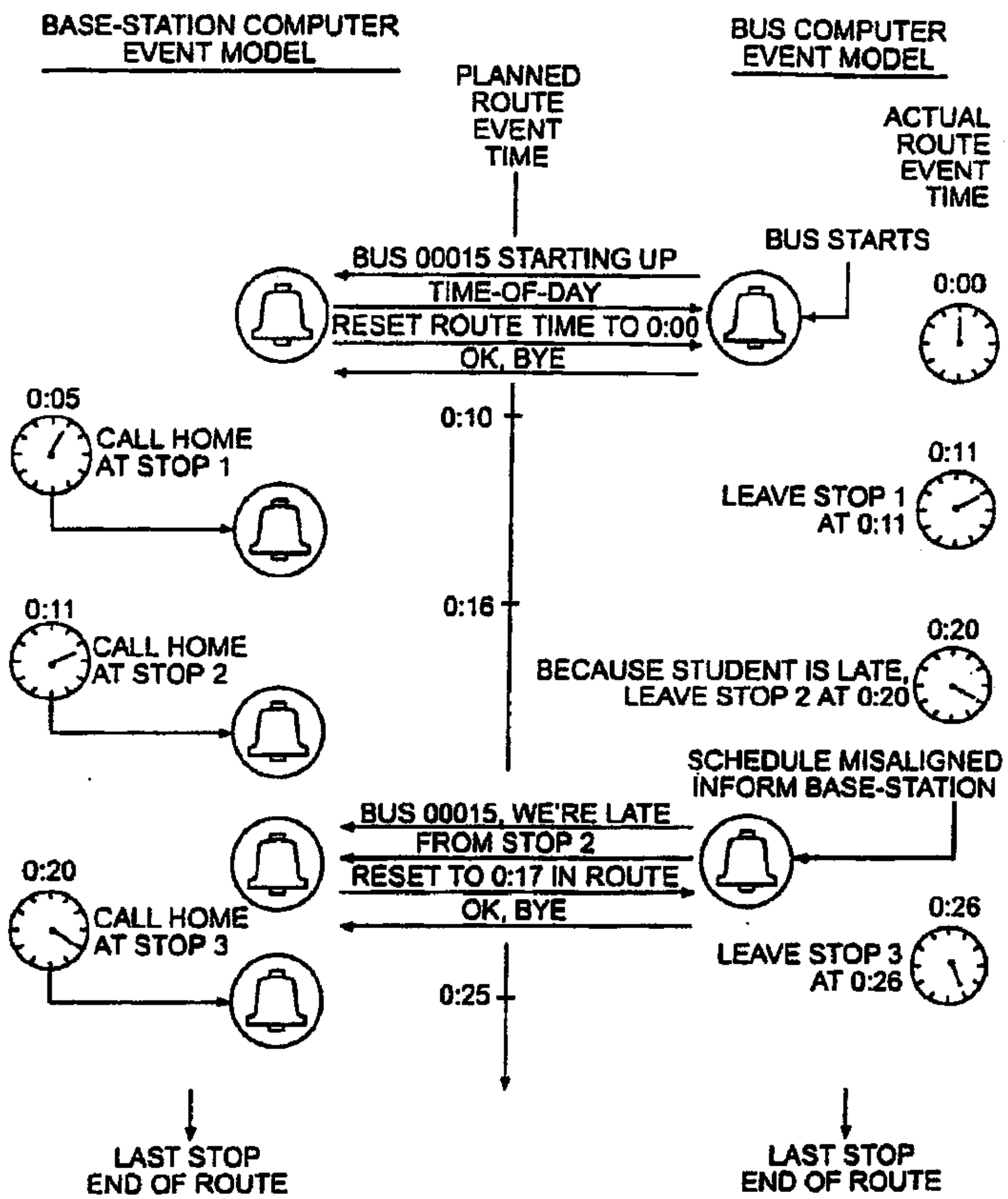
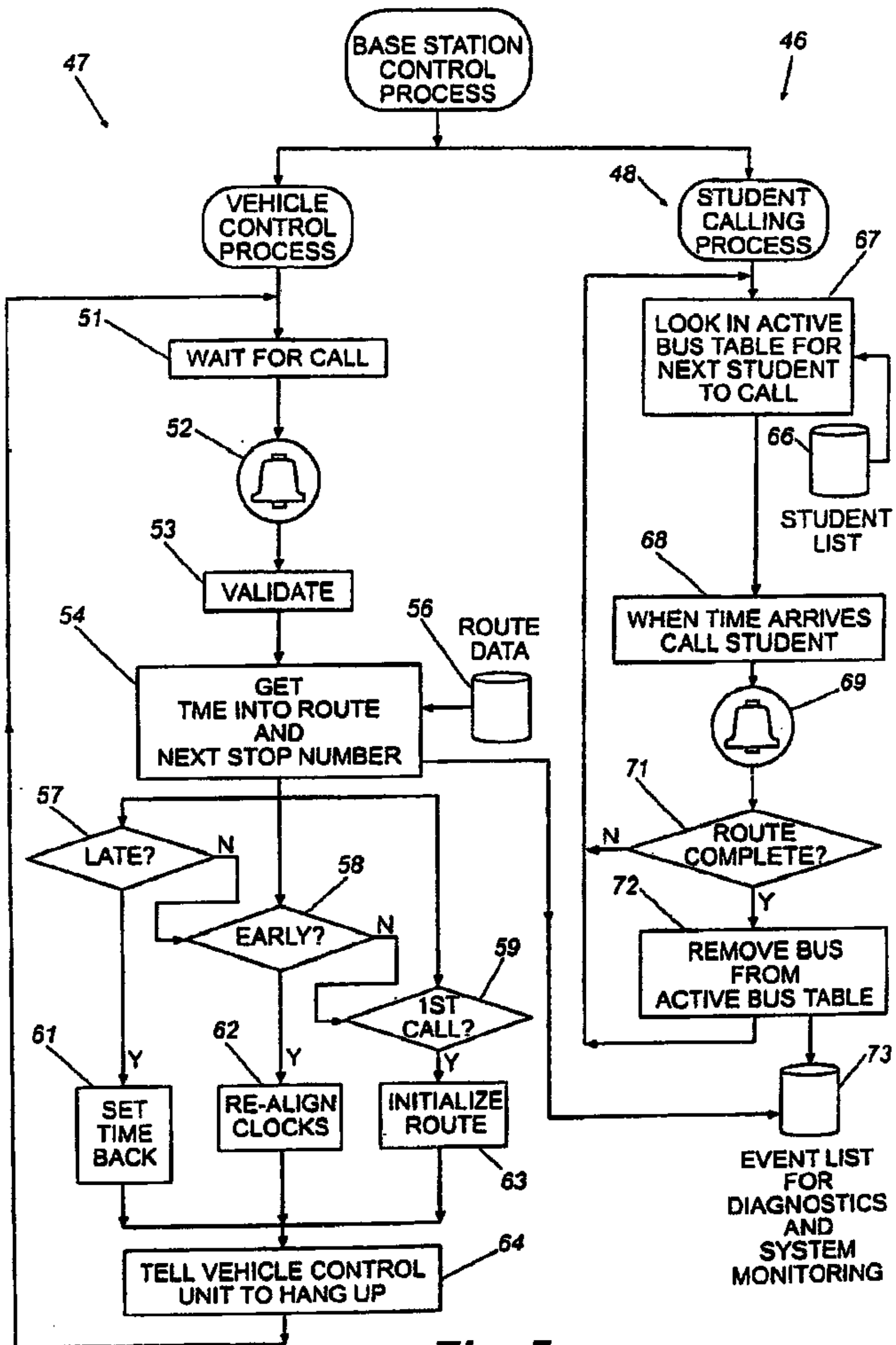
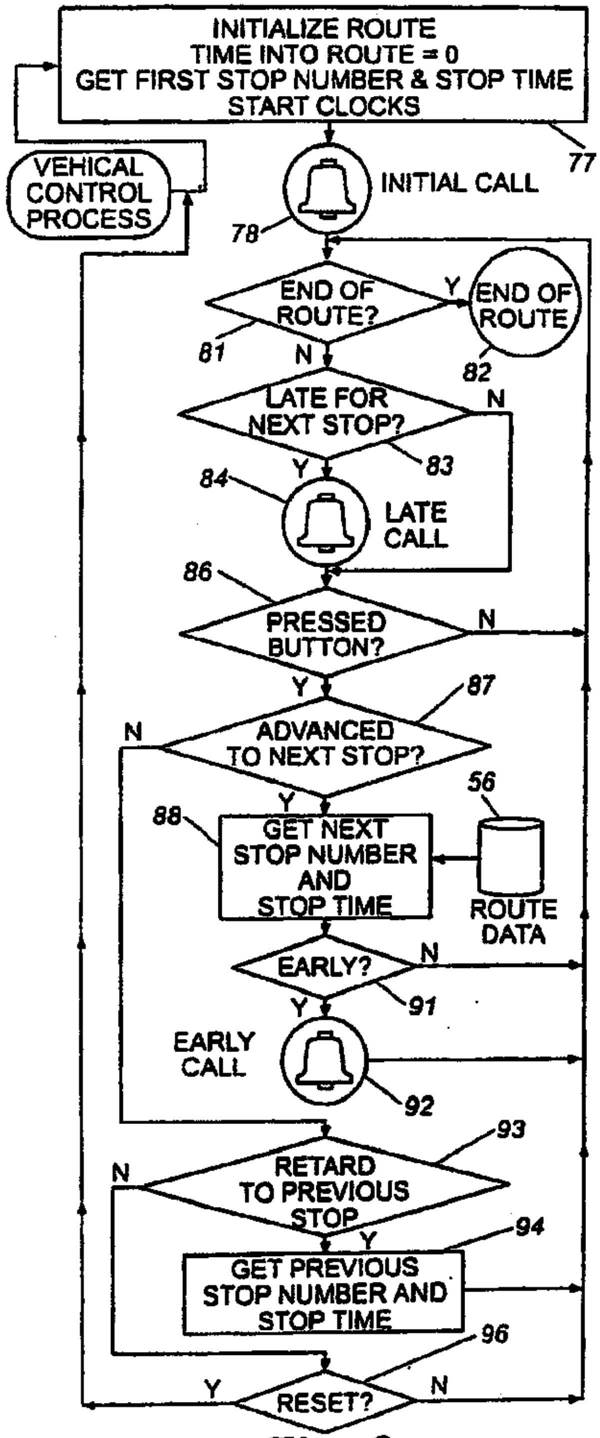

BASE-STATION COMPUTER EVENT MODEL
PLANNED ROUTE EVENT TIME
BUS COMPUTER EVENT MODEL
ACTUAL ROUTE EVENT TIME
BUS STARTS
BUS 00015 STARTING UP
TIME-OF-DAY
RESET ROUTE TIME TO 0:00
OK, BYE
0:00
0:05
CALL HOME AT STOP 1
0:10
0:11
LEAVE STOP 1 AT 0:11
0:11
CALL HOME AT STOP 2
0:16
0:20
BECAUSE STUDENT IS LATE, LEAVE STOP 2 AT 0:20
SCHEDULE MISALIGNED INFORM BASE-STATION
BUS 00015, WE'RE LATE
FROM STOP 2
RESET TO 0:17 IN ROUTE
OK, BYE
0:20
CALL HOME AT STOP 3
0:26
LEAVE STOP 3 AT 0:26
0:25
LAST STOP END OF ROUTE
LAST STOP END OF ROUTE

*Fig. 4B*



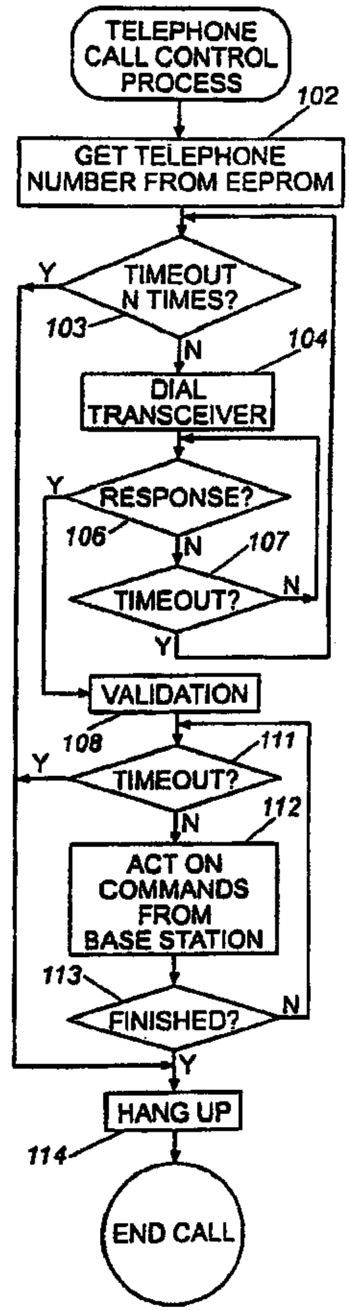
47
46
BASE STATION CONTROL PROCESS
VEHICLE CONTROL PROCESS
48
STUDENT CALLING PROCESS
67
51
WAIT FOR CALL
LOOK IN ACTIVE BUS TABLE FOR NEXT STUDENT TO CALL
52
66
STUDENT LIST
53
68
VALIDATE
WHEN TIME ARRIVES CALL STUDENT
54
56
ROUTE DATA
GET TME INTO ROUTE AND NEXT STOP NUMBER
69
71
57
LATE?
N
58
ROUTE COMPLETE?
N
72
Y
EARLY?
N
REMOVE BUS FROM ACTIVE BUS TABLE
59
1ST CALL?
61
62
Y
Y
Y
73
SET TIME BACK
RE-ALIGN CLOCKS
INITIALIZE ROUTE
63
EVENT LIST FOR DIAGNOSTICS AND SYSTEM MONITORING
64
TELL VEHICLE CONTROL UNIT TO HANG UP


Fig. 5



76
INITIALIZE ROUTE
TIME INTO ROUTE = 0
GET FIRST STOP NUMBER & STOP TIME
START CLOCKS
77
VEHICAL CONTROL PROCESS
INITIAL CALL
78
END OF ROUTE?
Y
END OF ROUTE
81
N
82
LATE FOR NEXT STOP?
N
83
Y
84
LATE CALL
86
PRESSED BUTTON?
N
Y
87
ADVANCED TO NEXT STOP?
N
Y
56
88
GET NEXT STOP NUMBER AND STOP TIME
ROUTE DATA
EARLY?
N
Y
91
EARLY CALL
92
93
RETARD TO PREVIOUS STOP
N
Y
94
GET PREVIOUS STOP NUMBER AND STOP TIME
96
Y
RESET?
N


Fig. 6



TELEPHONE CALL CONTROL PROCESS
102
GET TELEPHONE NUMBER FROM EEPROM
Y
TIMEOUT N TIMES?
103
N
104
DIAL TRANSCEIVER
Y
RESPONSE?
106
N
107
TIMEOUT?
N
Y
VALIDATION
108
111
Y
TIMEOUT?
N
112
ACT ON COMMANDS FROM BASE STATION
113
FINISHED?
N
Y
HANG UP
114
END CALL


Fig. 7

## NOTIFICATION SYSTEM AND METHOD THAT INFORMS A PARTY OF VEHICLE DELAY

This application is a continuation of application No. 09/992,817, filed Nov. 6, 2001, now U.S. Pat. No. 6,700, 507, which is a continuation of application No. 09/233,795, filed Jan. 19, 1999, now U.S. Pat. No. 6,313,760, which is a continuation of the application No. 08/407,319, filed Mar. 20, 1995, now abandoned, which is a continuation-in-part of application No. 08/063,533, filed May 18, 1993, now U.S. Pat. No. 5,400,020.

Each of the aforementioned patents and patent applications is incorporated herein by reference.

### FIELD OF THE INVENTION

The present invention generally relates to data communications and information systems and, more particularly, to advance notification systems and methods for notifying users in advance of the impending arrival of a vehicle or user, for example but not limited to, a bus, train, delivery van, plane, fishing vessel, or other vessel at a particular vehicle stop.

### BACKGROUND OF THE INVENTION

There are many situations when it is desirable for people to know of the approximate arrival time of a particular transportation vehicle shortly before the vehicle is to arrive at a particular destination. For example, a person having to pick up a friend or relative at a commercial bus station either has to call the bus station to find out the approximate arrival time (information which is oftentimes unavailable) or plan on arriving at the bus station prior to the scheduled arrival time of the bus and hope the bus is not delayed.

Another example is in the commercial fishing industry, wherein fish markets, restaurants, and other establishments desire to purchase fish immediately upon arrival of a commercial fishing boat at a port. Currently, such establishments, in order to ensure being able to purchase the freshest catch often depend on predetermined schedules of fishing fleets, which are not always accurate or reliable.

Still another example involves school children that ride school buses. School children who ride buses to school often have to wait at their bus stops for extended lengths of time because school buses arrive at particular bus stops at substantially different times from one day to the next. The reason is that school buses are not always the best-maintained vehicles on the roads, frequently operate during rush hour traffic, and must contend with congested urban/suburban conditions. As a result, school children are forced to wait at their bus stops for long periods of time, oftentimes in adverse weather conditions, on unlit street corners, or in hazardous conditions near busy or secluded streets. If it is raining, snowing, windy and cold, and/or even dark, such conditions can be unhealthy and unsafe for children.

Thus, generally, it would be desirable for a user to know when a vehicle (such as a bus, truck, train, plane, or the like) is (a) a particular time period (for example, number of minutes or seconds) away from arriving at a destination, (b) a particular distance (for example, number of miles or height) away from the destination, or (c) at a particular location among a set of location points, so that the user can adjust his/her schedule and avoid arriving too early or too late.

In the past, in order to combat the arrival time problem in the context of school buses, student notification systems



have been employed that use a transmitter on each bus and a receiver inside each student home. U.S. Pat. No. 4,713,661 to Boone et al. and U.S. Pat. No. 4,350,969 describe systems of this type. When the school bus and its on-board transmitter come within range of a particular home receiver, the transmitter sends a signal to notify the student that his/her school bus is nearby. While such notification systems work satisfactorily under certain circumstances, nevertheless, these systems are limited by the range of the transmitters and require the purchase of relatively expensive receivers for each student. In addition, such systems provide little flexibility for providing additional information to the students, such as notifying them of the delayed arrival of a bus, alternative bus route information, or information regarding important school events.

### SUMMARY OF THE INVENTION

An object of the present invention is to overcome the deficiencies and inadequacies of the prior art as noted above and as generally known in the industry.

Another object of the present invention is to provide an advance notification system and method for according advance notification of the impending arrival of a vehicle at a particular vehicle stop.

Another object of the present invention is to provide an advance notification system and method for according advance notification to school students of the impending arrival of a school bus at a particular vehicle stop.

Another object of the present invention is to provide an advance notification system and method for inexpensively according advance notification of the impending arrival of a vehicle at a particular vehicle stop.

Another object of the present invention is to provide an advance notification system that is reliable in operation and flexible in design to permit customization to a particular application.

Briefly described, the present invention is an advance notification system for notifying passengers of an impending arrival of a vehicle as the vehicle progresses along a scheduled route with particular stop locations and corresponding scheduled times of arrival at the stop locations. The advance notification system generally comprises a vehicle control unit (VCU) disposed on each vehicle and a base station control unit (BSCU) which is configured to communicate with all of the vehicle control units and with passenger telephones.

The VCU includes a vehicle control mechanism, a vehicle communication mechanism controlled by the vehicle control mechanism, a vehicle clock for tracking elapsed time of the vehicle while on the scheduled route to determine when the vehicle is early, late, and on time along the scheduled route, optional input switches (e.g., start/reset, advance stop number, move stop number back) that can be operated by the vehicle driver to indicate when the vehicle has reached particular stops along the route, and optional sensors (e.g., positioning system input, etc.) for signaling to the vehicle control mechanism when the vehicle is early, late, and on time along the scheduled route. The control mechanism is adapted to initiate calls utilizing the vehicle communication mechanism when the elapsed time and/or traveled distance of the vehicle at any of the particular positions is either ahead or behind the scheduled time and/or distance. In the preferred embodiment, the vehicle communication mechanism is a wireless communication interface, such as a mobile telephone, radio frequency (RF) transceiver, or other suitable device.

The BSCU has a base station communication mechanism and a base station control mechanism for controlling the base station communication mechanism. The base station communication mechanism receives the call from the VCU and receives the amount of time and/or distance in which the vehicle is ahead or behind relative to the schedule. The base station control mechanism causes calls to be made to each of the passengers to be boarded at a particular stop location via the base station communication mechanism prior to the arrival of the vehicle at the particular stop location. In the preferred embodiment, the base station communication mechanism is a wireless communication device, such as a mobile telephone or RF transceiver (includes both transmitter and receiver), for communicating with the vehicle communication mechanism and also comprises at least one telephone for calling passenger telephones.

In accordance with a significant feature of the present invention, the telephone call to advise a passenger of the impending arrival of the vehicle preferably can exhibit a distinctive telephone ring sound so that the call recipient need not answer the telephone in order to receive the message. Moreover, the distinctive telephone ring sound can be coded by any sequence and duration of rings and/or silent periods.

It should be emphasized that while the present invention is particularly suited for application to school buses, there are many other applications. As examples, the advance notification system and method of the present invention could be employed with commercial buses, trains, planes, pickup vehicles, delivery vehicles, fishing vessels, and numerous other transportation vehicles.

Other objects, features, and advantages of the present invention will become apparent from the following specification, when read in conjunction with the accompanying drawings. All such additional objects, features, and advantages are intended to be included herein.

## BRIEF DESCRIPTION OF THE DRAWINGS

The present invention can be better understood with reference to the following drawings. The drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present invention. Moreover, like reference numerals designate corresponding parts throughout the several views.

FIG. **1** is a high level schematic diagram of an advance notification system of the present invention as applied to a school bus system, as an example, the advance notification system generally comprising vehicle control units (VCU) in communication with a base station control unit (BSCU), which is in turn in communication with passenger telephones;

FIG. **2** is a high level schematic diagram of the VCU of the advance notification system of FIG. **1**;

FIG. **3** is a low level block diagram of the VCU of FIGS. **1** and **2**;

FIG. **4A** is a flow chart of the overall operation of the advance notification system of FIG. **1**;

FIG. **4B** is a an example of a schedule for a sequence of events illustrating the operation of the advance notification system of FIG. **1**;

FIG. **5** is a flow chart of a base station control process for the base station control unit **14** of FIG. **1**;

FIG. **6** is a flow chart of a vehicle control process for the VCU of FIGS. **1** and **2**; and

FIG. **7** is a flow chart of a telephone call control process for the VCU of FIGS. **1** and **2**.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The features and principles of the present invention will now be described relative to preferred embodiments thereof. It will be apparent to those skilled in the art that numerous variations or modifications may be made to the preferred embodiments without departing from the spirit and scope of the present invention. Thus, such variations and modifications are intended to be included herein within the scope of the present invention, as set forth and defined in the claims.

### I. System Architecture

Referring now in more detail to the drawings, wherein like reference numerals designate corresponding parts throughout the several views; FIG. **1** is a schematic diagram of the advance notification system **10** of the present invention, as configured to operate for example, but not limited to, a school bus system.

The advance notification system **10** includes, preferably, a plurality of on-board vehicle control units (VCU) **12**, a single base station control unit (BSCU) **14**, and a plurality of passenger telephones **29**. As configured in the school bus system **10**, a VCU **12** is installed in each of a plurality of school buses **19**, all of which communicate with the single BSCU **14**. Moreover, the BSCU **14** communicates with the telephones **29** at one or more passenger locations **36**, or student homes in the present exemplary application.

#### A. Vehicle Control Unit

The VCU **12** will now be described with reference to FIGS. **1**, **2**, and **3**. Referring first to FIG. **1**, each VCU **12** includes a microprocessor controller **16**, preferably a model MC68HC705C8P microprocessor controller that is manufactured by and commercially available from the Motorola Corporation, USA. The microprocessor controller **16** is electrically interfaced with a communication mechanism **18**, preferably a wireless communication device, for enabling intercommunication of data with the BSCU **14**. Examples of suitable wireless communication devices include a mobile telephone (e.g., cellular) and a transceiver (having both a transmitter and a receiver) operating at a suitable electromagnetic frequency range, perhaps the radio frequency (RF) range.

In the embodiment using a wireless RF transceiver as the communication mechanism **18**, data can be sent in bursts in the form of in-band tones, commonly called "twinkle tones". These tone bursts can occur in the background of an existing voice channel. Twinkle tones are oftentimes used in transportation systems, such as taxicab communications systems.

The microprocessor controller **16** is electrically interfaced with a start/reset switch **21**, a move forward switch **22**, a move backward switch **23**, a clock **24**, and optionally, sensors **25*a*–25*d***. Generally, vehicle tracking is accopmlished by monitoring the control switches **21–23**, the sensors **25*a*–25*e***, the power to the controller **16**, and a route database (FIG. **5**). It is recommended that all of the foregoing features be employed to provide redundant checking.

More specifically, the start/reset switch **21** can be actuated by the bus driver upon starting along the bus's scheduled route to initialize the system **10**. The move forward switch **22** can be actuated by the bus driver upon reaching a bus stop in order to inform the VCU **12** that a stop has been made, the details of which will be further described hereinafter. The move backward switch **23** can be actuated by the bus driver at a bus stop if the bus driver has erroneously toggled the move forward switch **22** too many times, as will be further described in detail hereinafter. This indicates to the microprocessor controller **16** that a display module **33** and memory must be updated. In essence, the move forward

switch **22** and the move backward switch **23** cause the next stop designation which is displayed on the display module **33** and stored in the VCU **12** to toggle forward and backward, respectively.

The VCU **12** can be configured so that the operation of the start/reset switch **21**, the move forward switch, and the move backward switch **23** are purely optional by the bus driver. In this configuration, the sensors **25***a*–**25***e* automatically accomplish the aforementioned functions of the switches **21**–**23**. However, in certain cases, the bus driver may want to use the switches to override the sensors **25***a*–**25***e*. One of these cases may be when a student rides a bus only two out of five school days. Rather than program the VCU **12** to track these unnecessary stops, the driver may manually control the stop number by the switches **21**–**23**.

The clock **24** tracks the elapsed time as the bus travels along its scheduled route and feeds the timing information to the microprocessor controller **16**.

The display module **33** informs the bus driver as to the number corresponding to the next stop and the time (preferably, in seconds) necessary to reach the next stop. Other types of information may also be displayed on the display module **33**. For example, the display module **33** may display the amount of time that the bus **19** is ahead of or behind schedule, the status of the VCU **12** in communication with the BSCU **14**, or, upon actuation of the start button **21**, that the advance notification system **10** is operating.

The optional sensors **25***a*–**25***e* include an odometer sensor **25***a* for determining distance into a route. The sensor **25***a* can be connected to the bus drive shaft and counts revolutions. This data can be used to determine the stop number.

A door sensor **25***b* can be used to count the number of door operations (opening/closing) of the front door **24** of the school bus **19**, which should correspond with the number of stops.

A swing arm sensor **25***c* can be implemented to count the number of times the arm operates. This operation should coincide with the number of stops.

A bus stop sign sensor **25***d* can be utilized to count the number of times the bus stop sign operates. This operation should coincide with the number of stops.

A positioning system **25***e* can be used to determine the geographical position of the bus **19** on the earth's surface. The positioning system **25***e* could be the GPS (global positioning system), the LORAN positioning system, the GLONASS positioning system (USSR version of GPS), or some other similar position tracking system.

FIG. **2** is a high level schematic circuit diagram of the VCU **12**. The VCU **12** is designed to be a compact unit with a generally rectangular housing **34** that is mounted preferably on or in front of the dashboard of the bus **19** in view and within reach of the bus driver. In the housing **34**, the microprocessor controller **16** is interfaced with the transceiver **18** by a transceiver jack **31** (preferably a conventional 8-conductor telephone jack when transceiver **18** is a mobile telephone), and the transceiver **18** includes an antenna **32** for transmitting and receiving signals to and from the BSCU **14**. Further, the VCU **12** includes a liquid crystal display (LCD) module **33** disposed for external viewing of the display by the bus driver for providing information to the bus driver, as described previously.

FIG. **3** is a more detailed schematic circuit diagram of the electronic components associated with the VCU **12**. The microprocessor controller **16** essentially controls the operation of the transceiver **18** and the LCD display module **33**. A switching element **37**, such as an optical isolator (opto isolator) unit **37**, provides a buffer between the microprocessor controller **16** and the battery **35** as well as switches **21**, **22**, **23**. An EEPROM **43** is provided for storing the control programs (FIGS. **6** and **7**) and other requisite data for the microprocessor controller **16**, and a RAM **44** is provided for running the control programs in the microprocessor controller **16**. A matrix keyboard emulator **39** is interfaced between the transceiver **18** and the microprocessor controller **16** for allowing the microprocessor controller to control and transmit signals over the transceiver **18**. Further, a dual tone multiple frequency decoder **41** is interfaced between the mobile telephone **18** and the microprocessor controller **16** for decoding modem signals, or tones, received by the mobile telephone **18** from the BSCU **14**.

B. Base Station Control Unit

The BCSU can be implemented by any conventional computer with suitable processing capabilities. The BCSU **14** can communicate to the homes of students via, for example but not limited to, any of the following interfaces: (a) dialing through multiple port voice cards to the passenger telephones **29**; (b) communication using a high-speed switch-computer applications interface (SCAI) to a digital switch operated by a telephone utility company; the SCAI adheres to the conventional OSI model and supports the carrying of application information in an application independent fashion; and (c) communication using an analog display services interface (ADSI) maintained by a telephone utility company. ADSI is a cost effective technology that delivers voice and data information between a telephone terminal and a digital switch or server using existing copper telephone lines.

In the preferred embodiment, the BSCU **14** communicates through multiple port voice cards to passenger telephones **29**. In this regard, a set of conventional voice processing cards are utilized for communicating with one or more student homes, as depicted in FIG. **1** as passenger locations **36**. The system **10** could be configured to merely call prospective passengers, thus warning them of the impending arrival of a bus **19**, as opposed to forwarding both a call and a message. In the preferred embodiment, the BSCU **14** includes at least one communication mechanism **26** and associated line **26'**, dedicated for communication with the VCUs **12**. However, as mentioned previously, the BSCU **14** may be designed to communicate with the VCUs **12** via any suitable wireless communication device, in which case, the BSCU **14** would include a corresponding transceiver having the ability to receive a plurality of signals from the plurality of vehicles **19**.

The BSCU **14** also includes at least one, but preferably a plurality of telephones **27** (or other suitable communication interface) with associated telephone lines **27'**, for making the telephone calls to the passenger locations **36**, or in this case, the homes **36** of the students and allow the telephone to ring predefined number of times so that it is not necessary for the telephone to be answered in order for the telephone call to be recognized as that of the advance notification system **10**.

The calling program (FIG. **7**) associated with the advance notification system **10** can also be configured to make the passenger telephone **29** exhibit a distinctive telephone ring sound, or pattern, so that the call recipient need not answer the telephone in order to receive the message. The distinctive telephone ring can be coded by any sequence and duration of rings and/or silent periods. A standard ring signal that is sent to a telephone from the telephone utility company is typically a periodic electrical analog signal having a frequency of 20 Hz and a peak-to-peak voltage amplitude of –48 volts. The ring signal is asserted on the telephone connection **29'** for a predefined time period for ringing the

telephone. The foregoing time period can be manipulated in order to derive a distinctive sequence and duration of rings and/or silent periods.

Implementation of a distinctive telephone ring can be accomplished by purchasing this feature from a telephone utility company. This feature is widely available to the public. Generally, telephone utility companies operate network switches, now usually digital, that serve as interfaces for telephonic communications. A particular geographic region is typically allocated to a particular switch(s). In essence, one or more distinctive telephone rings can be driven by software running in the switches to a particular telephone. Examples of switches that a recommercially available to telephone utility companies are as follows: a model DMS 100 by Northern Telecom, Canada; a model 5ESS by AT&T, U.S.A.; and a model EWSD by Siemans Stromberg-Carlson Corp., Germany.

The feature for establishing the distinctive telephone ring is sold to the public under several different commercial trade names, depending upon the telephone utility company. Examples are as follows: Call Selector by Northern Telecom, Canada; Ringmaster by Bell South, U.S.A.; Smartlink by SNET, U.S.A.; Multi-ring by Ameritech, U.S.A.; Priority Ring by PacBell, U.S.A.; Priority Call by Cincinnati Bell, U.S.A.; and Ring Me by Standard Telephone Co., U.S.A.

Furthermore, in the case where a parent or a student answers the telephone call from the base station unit **14**, a prerecorded message may be played by the BSCU **14**. An example of such a message would be: "The bus will arrive in five minutes," as indicated in FIG. **1** at the reference numeral **30**.

II. System Operation

A. Initialization

Initially, the bus schedule for each bus **19** is programmed into the advance notification system **10** by having the respective bus driver drive his respective bus one time along the corresponding scheduled bus route at the approximate speed the bus would usually travel on the route and with the bus driver making all the scheduled stops along the route and waiting at each stop for the approximate time it would take for all the students at that stop to board the bus **19**. As the bus driver drives the bus **19** along the route for initialization purposes, the internal real time clock **24** runs and the bus driver actuates the switches **21**, **22**, **23** as required in accordance with the principles described previously. The timing information is recorded in the memory (RAM **44** and EEPROM **43**) of the VCU **12**.

The timing information which is recorded during the initialization of the system **10** is used as a reference during the usual operation of the system **10** for the purpose of determining whether a bus **19** is early or late at each of the bus stops. In the preferred embodiment, determining the status (i.e., early, on time, late) of a bus **19** is accomplished by comparing the time at which a bus **19** actually departs from a stop to the scheduled time of departure.

However, it should be emphasized that other methodologies could be utilized for determining whether the bus **19** is early or late at an instance in time. For example, the odometer **25***a* of the bus **19**, as indicated by phantom lines in FIG. **1**, could be monitored by the microprocessor controller **16**. At particular times, the odometer mileage reading could be compared to reference odometer mileage readings which were obtained during the initialization of the system **10**. In this way, the determination of whether a bus **19** is early or late can occur at any time during a bus route and can occur as many times as desired.



Another methodology which could be utilized for determining whether the bus **19** is early or late involves interfacing the VCU **12** with the positioning system **25***e*, as shown in FIG. **1** by phantom lines. From the geographical position data received from the positioning system **25***e*, the microprocessor controller **16** could determine where the bus **19** is situated on the earth at any given time. The bus location at a particular time could then be compared with scheduled locations and scheduled times in order to determine whether the bus **19** is early or late and by what amount.

B. Regular Operation

The overall operation of the advance notification system **10** will be described with reference to FIGS. **4**A and **4**B. FIG. **4**A sets forth a flow chart showing the overall operation after the system **10** has been initialized. FIG. **4**B shows an example of a schedule of possible events and the interactions which might occur between the VCU **12** and the BSCU **14** as the bus **19** travels along its scheduled route and makes its scheduled stops.

In FIG. **4**B, the left hand column illustrates the sequence of events for the BSCU **14**, and the right hand column illustrates the sequence of events on the VCU **12**. Between the right and left hand columns is illustrated a time line for the scheduled bus stops. The time line has the following time designations: ten minutes, sixteen minutes, and twenty-two minutes, all along the scheduled bus route.

First, the bus ignition is switched on, as indicated in FIG. **4**A at block **45***a*. At the beginning of the bus route, the system **10** could be configured to automatically initialize itself upon power up of the VCU **12**, and further, the unit **12** could be programmed to make initial contact with the BSCU **14** after the bus **19** moves a predefined distance, such as ⅛ mile, as determined by the odometer sensor **25***a*. This initialization action causes the microprocessor controller **16** to telephone the BSCU **12** to inform the BSCU **12** that the bus **19** is beginning its route and to initialize the BSCU **14** relative to the VCU **12**. The foregoing action is indicated at flow chart block **45***b* (FIG. **4**A). Alternatively, the bus driver can press the start/reset switch **21** on the VCU **12** to initialize the VCU **12**.

After initialization of the VCU **12**, the display module **33** preferably displays "Stop Number 1" followed by the amount of time to reach stop number **1**. The time continuously runs as the bus **19** progresses along the bus route.

Next, as indicated at flow chart block **45***c* (FIG. **4**A), the VCU **12** determines, continuously or periodically, if the bus **19** is on time by analyzing the status of devices **21**–**25** (FIG. **1**) in view of planned route data (derived from initialization). In the preferred embodiment, the VCU **12** at least compares its elapsed time from the clock **24** (FIG. **1**) with its scheduled time from the planned route data. When the bus **19** is on time, the VCU **12** does not contact the BSCU **14**, and the BSCU **14** commences calling students at the predefined time prior to arrival of the bus **19** at the particular bus stop, as indicated in flow chart block **45***e* (FIG. **4**A). In the example of FIG. **4**B, at five minutes along the scheduled route, the BSCU **14** places a telephone call to the homes **36** of the school children to be picked up at bus stop number **1**.

However, when the VCU **12** determines that the bus **19** is early or late at this juncture, the VCU **12** contacts the BSCU **14**, as indicated at flow chart block **45***d* (FIG. **4**A), and the BSCU **14** adjusts its student calling lists accordingly so that the students are called in accordance with the predefined time notice, e.g., five minutes.

Further, as indicated at flow chart block **45***f* (FIG. **4**A), the VCU **12** again determines, continuously or periodically, if the bus **19** is on time by analyzing the devices **21**–**25** (FIG.

1). Preferably, in this regard, the VCU **12** at least compares its elapsed time with its scheduled time.

Back to the example of FIG. 4B, at ten minutes along the schedule, the bus **19** arrives at the bus stop number **1** and takes one minute to load all the students at this stop onto the bus **19**. Just prior to leaving stop **1**, the bus driver actuates the move forward switch **22**. Upon actuating the move forward switch **22**, the display module **33** preferably displays "Stop Number **2**" followed by the amount of time to reach stop number **2**. The foregoing feedback signal may be generated by one of the sensors **25*a*–25*e*** so that the bus driver need not actuate the move forward switch **22**.

In accordance with flow chart block **45*f*** (FIG. 4A), the microprocessor controller **16** checks the elapsed time of eleven minutes to confirm that such time corresponds to the programmed time for bus stop number **1**. It will determine whether the bus **19** is early or late. If the bus **19** is either early or late, the VCU **12** will call the BSCU **14** to inform the unit **14** of this fact, as indicated at flow chart blocks **45*g*** and **45*h*** (FIG. 4A). If the bus **19** is on time, then the VCU **12** will continue to monitor the inputs from devices **21–25**, as indicated in flow chart block **45*j***. In the example of FIG. 4B, it is assumed that the bus **19** is neither early nor late in leaving bus stop number **1**.

Because the bus **19** is scheduled to arrive at bus stop number **2** at sixteen minutes along the route, at eleven minutes along the route the BSCU **14** places telephone calls to the homes **36** of the school children who board the bus **19** at bus stop number **2**, as indicated at flow chart block **45*k*** (FIG. 4A).

The bus **19** then arrives at bus stop number **2** and commences the boarding of students. However, because one of the school children is running late that particular morning, the bus **19** spends three minutes at bus stop number **2**, and, thus, gets three minutes behind schedule. Thus, the bus departs at twenty minutes along the route.

At this time, the VCU **12** makes an inquiry as to whether there are any more bus stops, as indicated in flow chart block **45*l***. If so, then the VCU **12** again monitors its travel status by checking devices **21–25** (FIG. 1), in accordance with flow chart block **45*f*** (FIG. 4A). If not, then the VCU **12** notifies the BSCU **14** of the end of the route, as indicated at flow chart block **45*m***.

In the example of FIG. 4B, upon receiving the information that the bus **19** is late, the microprocessor controller **16** compares the departure time to the scheduled departure time of seventeen minutes, pursuant to flow chart block **45*f*** (FIG. 4A), and determines that the bus **19** is three minutes behind schedule, in accordance with flow chart blocks **45*g*** (FIG. 4A). The microprocessor controller **16** then telephones the BSCU **14** to inform the BSCU **14** that the bus **19** is three minutes behind schedule, as indicated in flow chart block **45*h*** (FIG. 4A). A fleet operator's screen associated with the BSCU **14** is updated to reflect the status of the late bus **19**, as indicated at flow chart block **45*i*** (FIG. 4A). Moreover, as indicated at flow chart block **45*d*** (FIG. 4A), the BSCU **14** then reschedules the telephone calls that are to be made to the parents of the students at bus stop number **3** from twenty-two minutes along the route to twenty-five minutes along the route and resets the VCU **12** to seventeen minutes along the route, the scheduled time for the bus to leave bus stop number **2**.

At twenty minutes along the route, the BSCU **14** calls the student homes **36** of the students corresponding to bus stop number **3**, in accordance with flow chart block **45*k*** (FIG. 4A), to inform them that the bus **19** is five minutes from arriving. At twenty-five minutes along the route, the bus **19** arrives at bus stop **3**, takes one minute to load the students on to the bus **19** and then proceeds onto the school.

At this time, the VCU **12** makes an inquiry as to whether there are any more bus stops, as indicated in flow chart block **45*l***. In the example of FIG. 4B, there are no more stops and, accordingly, the VCU **12** notifies the BSCU **14** of the end of the route, as indicated at flow chart block **45*m***.

Finally, worth noting is that the system **10** may be configured so that if a bus **19** becomes delayed by more than a maximum length of time, such as fifteen minutes, the BSCU **14** immediately calls the homes **36** of the remaining students to board the bus **19** in order to notify these homes **36** of the unusual delay and to notify these homes **36** to wait for a notification call.

III. Control Processes

FIGS. **5** through **7** show flow charts pertaining to control processes or algorithms performed in the advance notification system **10** of FIG. **1** in order to achieve the functionality as set forth in FIGS. **4**A and **4**B as described hereinbefore. These flow charts illustrate the best mode for practicing the invention at the time of filing this document. More specifically, FIG. **5** illustrates a base station control process **46** employed in the BSCU **14**, and FIGS. **6** and **7** show respectively a vehicle control process **76** and a telephone call control process **101** implemented in the VCU **12**. The foregoing control processes are merely examples of plausible control algorithms, and an infinite number of control algorithms may be employed to practice the present invention. Furthermore, it should be noted that the base station control process **46** of FIG. **5** is implemented via software within any conventional computer system, and the vehicle control process **76** of FIG. **6** and the telephone call control process **101** of FIG. **7** are both implemented via software stored within memory and are run by the microprocessor controller **16**. However, these control operations need not be implemented in software and could be implemented perhaps in hardware or even manually by human interaction.

A. Base Station Control Process

With reference to FIG. **5**, the base station control program **46** essentially comprises two control subprocesses which run concurrently, namely, (a) a vehicle communications process **47** and (b) a student calling process **48**. The vehicle communications process **47** will be described immediately hereafter followed by the student calling process **48**.

1. Vehicle Communications Process

The vehicle communications process **47** initially waits for a telephone call from one of the VCUs **12** located on one of the plurality of buses **19**, as indicated by a flow chart block **51**. The vehicle communications process **47** is preferably capable of monitoring a plurality of telephone connections **26'** for receiving information from a plurality of buses **19**. As the number of buses **19** is increased, the number of telephone connections **26'** which are monitored by the vehicle communications program **47** should also be increased to an extent.

After the start of a bus **19** along its route, the respective VCU **12** will initiate a telephone call to the BSCU **14**, as indicated by the telephone bell symbol **52**. After the BSCU **14** receives the telephone call, a string of symbols is exchanged between the VCU **12** and the BSCU **14** so as to validate the communication connection, as indicated in a flow chart block **53**. In other words, the BSCU **14** ensures that it is in fact communicating with the VCU **12**, and vice versa.

Next, as shown in a flow chart block **54**, the BSCU **14** asks the VCU **12** for information regarding (a) the time into the route and (b) the number designating the next stop. In

addition, route data **56** is obtained from a local data base. The route data **56** includes information pertaining to each bus stop and how much time it should take to reach each bus stop during the route. From the route data **56** and the information (a) and (b) received from the VCU **12**, the BSCU **14** can determine whether the bus **19** is late or early, as indicated by flow chart blocks **57**, **58**, or whether the bus **19** has just started its route, as indicated by a flow chart block **59**. In the case where the bus **19** is late, the BSCU **14** advises the VCU **12** to reset its on-board clock **24** back so that it thinks it is on time, as indicated in a flow chart block **61**. In the case where the bus **19** is early, the BSCU **14** advises the VCU **12** to move its on-board clock **24** forward so that the VCU **12** thinks it is on time, as indicated in flow chart block **62**. Moreover, in the situation where the bus **19** has just started its route and the telephone call is essentially the first call of the route, the base station clock **28** and the on-board vehicle clock **24** are synchronized, as indicated in a flow chart block **63**.

Finally, as shown in a flow chart block **64**, the BSCU **14** informs the VCU **12** to terminate the telephone call, which was initiated in the flow chart block **51**. The vehicle communications program **47** then proceeds once again to the flow chart block **51**, where it will remain until receiving another telephone call from the bus **19**.

Worth noting from the foregoing discussion is the fact that the BSCU **14** is the ultimate controller of the advance notification system **10** from a hierarchical vantage point. The base station clock **28** maintains the absolute time of the advance notification system **10**, while the vehicle clock **24** assumes a subservient role and is periodically reset when the bus **19** is at the start of a route or when the bus **19** is either early or late during the route. Further, it should be noted that the VCU **12** communicates to the BSCU **14** only (a) when the bus **19** is at the start of a route, (b) when the bus **19** is either early or late during the route, and (c) when the bus **19** completes its route, so as to minimize the amount of time on the mobile telephone network and associated costs thereof.

2. Student Calling Process

As previously mentioned, the student calling process **48** runs concurrently with the vehicle communications process **47** within the BSCU **14**. In essence, the student calling process **48** uses the timing information retrieved from the bus **19** by the vehicle communications process **47** in order to call students and inform them of the approaching bus **19**. A student list **66** is locally accessible from a local data base by the BSCU **14** and comprises information regarding (a) student names, (b) student telephone numbers, and (c) the time into a bus route when a student should be called via telephone. In accordance with the student calling process **48**, as indicated in a flow chart block **67**, the student list **66** is consulted as time progresses and telephone numbers are retrieved. When a particular time for calling a particular student is reached, the student calling process **48** initiates a telephone call to the particular student, as shown in flow chart blocks **68**, **69**. The telephone call can be made by using a distinctive telephone ring or a predefined number of rings, as described previously. Moreover, the particular time is fully selectable by programming.

Also worth noting is that the process can also include a feature for monitoring calls to be placed in the future. In accordance with this feature, upon anticipation of a heavy load of calls, some of the calls would be initiated earlier than the originally scheduled, corresponding call time.

After the bus route has been completed by the bus **19**, the particular bus and bus route are removed from consideration, as indicated by flow chart blocks **71**, **72**. Otherwise, the student calling program **48** returns to the student list **66** and searches for the next student to be called.



As further shown in FIG. **5**, an event list **73** is maintained for diagnostics and system monitoring. The event list **73** receives data from both the vehicle communications process **47** and the student calling process **46**. The event list **73** essentially comprises records of, among other things, all telephone calls and all past and current bus locations.

B. Vehicle Control Process

Reference will now be made to the vehicle control process **76** shown in FIG. **6**. Initially, as indicated in the flow chart block **77** of the vehicle control process **76**, the VCU **12** runs through an initiation procedure in which the first stop number is retrieved, the stop time (time necessary to travel to the next stop) is retrieved, and the time into the route as indicated by the clock **24** is set at zero and the clock **24** is started. After the foregoing initialization procedure, a call is initiated via the transceiver **18** to the BSCU **14**, as indicated by the bell symbol **78**. After the connection, the VCU **12** and the BSCU **14** exchange information as described hereinbefore and which will be further described hereinafter relative to FIG. **7**.

Next, as shown in FIG. **6**, the vehicle control process **76** begins a looping operation wherein the VCU **12** continuously monitors the switches **21**–**23**, clock **24**, and sensors **25***a*–**25***e*, if present, to determine whether the bus **19** is early or late. As mentioned previously, the vehicle control process **76** initiates a call only at start-up of a route, or when the bus **19** is either early or late, and not when the bus **19** is on time.

While in the main looping operation, a determination is first made as to whether the bus **19** has reached the end of the route, as indicated in a decisional flow chart block **81**. If the bus **19** is at the end of its route, then the vehicle control process **76** stops, as indicated in a flow chart block **82**, and does not start unless the start/reset switch **21** is triggered by the bus driver. Otherwise, the process **76** continues and makes a determination as to whether the bus **19** is late for the next stop, as indicated in a decisional flow chart block **83**. In the preferred embodiment, the bus **19** is considered late if the bus **19** arrives at a stop more than a predetermined late time period, such as 50 seconds, after when it should have arrived. If the bus **19** is late, then a call is initiated to the BSCU **14**, as shown by a bell symbol **84** in FIG. **7**.

If the bus is not late, then the process **76** determines whether any of the switches **21**, **22**, **23** have been actuated, as indicated in a decisional flow chart block **86**. If none of the switches **21**, **22**, **23** have been actuated, then the process **76** will loop back around and begin flow chart block **81** once again. Otherwise, if actuation of a switch **21**, **22**, **23** is detected, then the process **76** will determine which of the switches **21**, **22**, **23** has been actuated.

First, the process **76** will determine whether the move forward switch **22** has been actuated, as indicated in the decision flow chart block **87**. If the bus driver has actuated the move forward switch **22**, then the VCU **12** will retrieve the next stop number and corresponding stop time, as indicated in flow chart block **88**, from a local data base having the route data **56**. Moreover, a decision will be made as to whether the **5** bus **19** is early for that particular stop, as indicated in the decision flow chart block **91**. In the preferred embodiment, the bus **19** is considered early if the bus **19** arrives at a stop more than a predetermined early time period, such as 50 seconds, earlier than when it should have arrived. If the bus is not early, then the process **76** will loop back and proceed again with the flow chart block **81**. Otherwise, a call will be initiated to the BSCU **14** to inform the unit **14** that the bus **19** is early, as illustrated by bell symbol **92** in FIG. **7**.

In the event that the bus driver has not actuated the move forward switch **22**, the process **76** proceeds to a decisional flow chart block **93** wherein the process **76** determines whether the move backward switch **23** has been actuated by the bus driver. If the move backward switch **23** has been actuated, then the process **76** obtains the previous stop number and stop time, as indicated in flow chart block **94**, displays these values on the display screen, and loops back to begin again with the flow chart block **81**.

In the event that the bus driver has not actuated the move backward switch **23**, then the process **76** determines whether the bus driver has actuated the start/reset switch **21**, as indicated in the decisional flow chart block **96**. If the start/reset switch **23** has not been actuated by the bus driver, then the process **76** loops back and begins again with the flow chart block **81**. Otherwise, the process **76** loops back and begins again with the flow chart block **77**.

C. Telephone Call Control Process

When a telephone call is initiated by the VCU **12** as indicated by the call symbols **78, 84, 92**, the VCU **12** follows a telephone call control process **101** as illustrated in FIG. **7**. Initially, the telephone number corresponding with the BSCU **14** is obtained from the EEPROM **43**, as indicated in a flow chart block **102**. Other information is also obtained, including among other things, the particular bus number, bus serial number, and bus route. Next, the control process **101** sets a time out variable to keep track of how many times a telephone connection has been initiated. The number n of allowable attempts is predetermined and is stored in the EEPROM **43**.

After the time out variable has been implemented as indicated in the flow chart block **103**, the VCU call control program **101** causes the transceiver **18** to be called, as indicated in the flow chart block **104**. The control process **101** requires the VCU **12** to wait for a response from the BSCU **14**. If the VCU **12** does not receive a response within a predetermined time out period, preferably 20 seconds, then the control process **101** loops back and begins again at the flow chart block **103**. Otherwise, when the control process **101** determines that a response has been received, a validation procedure ensues, as indicated in a flow chart block **108**. The validation process indicated at the flow chart block **108** is that which was described previously relative to the flow chart block **53** of FIG. **5**. Essentially, it involves the exchange of symbols in order to assure a proper connection.

At the commencement of the validation process, another time out variable is set and will trigger termination of the telephone connection after a predetermined time period has run. The initiation of the time out variable and monitoring of the same is indicated in FIG. **7** at flow chart block **111**. If the time out variable triggers termination of the telephone connection, then the control process **101** will hang up and end the call, as illustrated by a flow chart block **114**. Otherwise, when the validation procedure has fully commenced, commands are passed from the BSCU **14** to the VCU **12**, as shown by a flow chart block **112**. Commands which may be sent to the VCU **12** include, for example, the following: (1) Is the bus **19** either early or late?; (2) Reset the vehicle clock **24**; (3) Record new information in the EEPROM **43**. It should be emphasized that the BSCU **14** may change the route information contained within the EEPROM **43** of the particular bus **19**. The foregoing features enables extreme flexibility of the advance notification system **10**.

Furthermore, the control process **101** determines whether the BSCU 14 has finished its communication over the mobile telephone, as indicated in a flow chart block **113**. Again, the VCU call control program **101** utilizes another time out variable to determine whether the BSCU **14** has finished. After the predetermined time period of the time out variable, the control process **101** will assume that the BSCU **14** has terminated its communication, and accordingly, the control process **101** will hang up the telephone, as indicated in a flow chart block **114**. Otherwise, the control process **101** will loop back and begin with the flow chart block **111** in order to accept another command from the BSCU **14**.

What is claimed is:

**1**. A method, comprising the steps of:

monitoring travel data associated with the vehicle;

comparing planned timing of the vehicle along a route to updated vehicle status information;

contacting a user communications device before the vehicle reaches a vehicle stop along the route; and

informing the user of the vehicle delay with respect to the vehicle stop and of updated impending arrival of the vehicle at the vehicle stop, based upon the updated vehicle status information and the planned timing.

**2**. A system, comprising:

means for monitoring travel data associated with a vehicle;

means for comparing planned timing of the vehicle along a route to updated vehicle status information;

means for contacting a user communications device before the vehicle reaches a vehicle stop along the route; and

means for informing the user of the vehicle delay with respect to the vehicle stop and of updated impending arrival of the vehicle at the vehicle stop, based upon the updated vehicle status information and the planned timing.

**3**. The method of claim **1**, wherein the comparing step includes the step of evaluating the vehicle's current location to a scheduled location in order to determine if the vehicle is on time or late.

**4**. The method of claim **1**, wherein the step of comparing includes the step of evaluating the vehicle's progress along the route in terms of time with respect to a scheduled time that the vehicle should reach a location.

**5**. The method of claim **1**, wherein the route has a plurality of vehicle stops and wherein the comparing step is performed based upon the vehicle's progress along the stops of the route.

**6**. The method of claim **1**, wherein the travel data comprises scheduled stop information.

**7**. The method of claim **6**, further comprising the step of updating the scheduled stop information based upon tracking information pertaining to the vehicle.

**8**. The method of claim **1**, wherein the method is performed by a computer system that is a single computer or that comprises a distributed architecture with a plurality of computers that are communicatively coupled.

**9**. The method of claim **2**, wherein the means for comparing includes a means for evaluating the vehicle's current location to a scheduled location in order to determine if the vehicle is on time or late.

**10**. The method of claim **2**, wherein the means for comprising includes a means for evaluting the vehicle's progress along the route in terms of time with respect to a scheduled time that the vehicle should reach a location.

**11**. The system of claim **2**, wherein the route has a plurality of vehicle stops and wherein the means for comparing analyzes the vehicle's progress along the stops of the route.

**12.** The system of claim **2**, wherein the travel data comprises scheduled stop information.

**13.** The system of claim **12**, further comprising a means for updating the scheduled stop information based upon tracking information pertaining to the vehicle.



**14.** The system of claim **2**, wherein the system is a single computer or comprises a distributed architecture with a plurality of computers that are communicatively coupled.

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